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Comparison between the competencies expected within the sheet metal industry and the competencies acquired in industrial/vocational senior high schools in Taiwan

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Comparison between the competencies expected within the sheet metal industry and the competencies acquired in industrial/vocational senior high schools in Taiwan

by

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CHAPTER I. INTRODUCTION

Background

To pursue long-term development in the economy and to take advantage of the manpower available are among the major goals of every country. Factors influencing economic development include natural resources, capital resources, and manpower resources. Depending upon their backgrounds, countries emphasize different factors for national needs. Two development problems exist in the newly industrialized country of Taiwan, Republic of China (R.O.C.): the first is limited natural resources, and the second is limited capital resources. A concomitant phenomenon is high population density: for example, in 1989, 555 persons on average inhabited each square kilometer of the country. Developing its manpower resources is the key issue of economic development for Taiwan, and emphasizing education is the most important strategy for promoting manpower quality.

In Taiwan, industrial/vocational education is the main source for cultivating skilled workers for industry. Since 1953, Taiwan has had six 4-years terms of economic development plans. The purpose of these terms has been to change the economic structure of the country from an agricultural to an industrial emphasis. In order to supply the tremendous number of skilled workers needed to reform the country's economic structure, the United Trade Training Curricula--which were suggested by the government of the United States of America--were announced by the Ministry of Education R.O.C. in 1955 and implemented in Industrial/Vocational Senior High Schools (IVSHS) nearly 30 years ago. Since then, industrial/vocational education has played an important role in developing manpower resources in Taiwan. It has enabled the economic progress rate there to increase an average of 9.1% per year from 1953 to 1979. Because of the country's rapidly developing economy, the United Trade Training Curricula have proved, nearly 30 years after their implementation, unable to meet the demand of the employment market. In 1980, as a result of the second petroleum crisis and economic competition from other developing countries, Taiwan's economic situation changed rapidly. In order to meet the challenge of the international economic impact, the government attempted to improve the promotion of industries. In other words, the capital- and technology-intensive industries were developed instead of the labor-intensive industries. According to the government publication "Long-term Economic Outlook for Taiwan, R.O.C." the development of heavy industry and high techonology were emphasized from 1974-1989. Obviously, skilled workers with better understanding of high techonology were needed. The quality of output in industrial/vocational education was different and amending the curricular standards to meet the needs of industrial development became necessary.

Three years ago, in 1986, the Ministry of Education amended the industrial/vocational education curricular standards in order to affect change in the economic structure of Taiwan. The curricula were based on the cluster concept developed at the University of Maryland. In the new curricula, there are five families of occupational clusters: mechanical, electrical and electronic, construction, chemical, and industrial arts, with the mechanical family being sub-divided into four departments: machine working, foundry working, auto repairing, and sheet-metal working. A model of the new curricula follows Figure 1, page 4.

Though the sheet metal department is listed as one of the mechanical divisions and the courses and contents have been announced in the curricular standards in IVSHS, no research was performed before the new curricula were implemented.

The question arises as to how the occupational clusters industrial cluster

mechanical family	electrical & electronic family	construction family	chemical family	industrial arts family
machine working	electrical power working	construction working	chemical working	printing working
foundry working	electrical control working	architecture designing		industrial arts working
auto repairing	refrigerating & air conditioning working	wood working		
sheetmetal working	electronic working	survey & construction planning		
	communication working	plumbing & pipefitting		

FIGURE 1: A model of the new curricula in 1986 in Taiwan

as well as departments within the clusters were decided. In keeping with the method developed by Donald Maley, the researcher identified the occupational clusters by referring to the Dictionary of Occupational Titles, the Classified Index of Occupations and Industries, the International Standard Classifications of Occupations, and other references in the military. The purpose of referring to so many sources was to avoid potential bias when choosing the clusters and departments.

Although the researcher developed the occupational clusters carefully, no perfect method of identifying the necessary skills and knowledge has been developed to cover all individual needs for employment because so many jobs exist in the work world. Further investigation into the types of skills and knowledge for sheet metal related jobs can help individuals to decide on their careers.

On the other hand, since technology has developed rapidly in the past decade and will continue to do so in the future, evaluating the curricula to meet the needs of industry is also important. The purpose of vocational education programs is to help individuals obtain employment. Investigating the types of skills and knowledge that are necessary for sheet metal related jobs can help the curriculum planner to discover specific jobs for which skill or knowledge bases or both have changed. These would be useful data to reference when amending curricular standards.

Statement of the Problem

Mechanical industries are the foundation of industrial development, and the sheet metal industry is one of the members of the mechanical industries. Comparing the job contents of sheet metal working to the job descriptions listed in the Dictionary of Occupational Titles and those listed in the Classified Index of Occupations and Industries, it becomes apparent that many occupations are involved in the sheet metal industry. Among these are auto-body repairing, sheet metal furniture manufacturing, ship building, air-conditioning, welding, cold metal working, and industrial piping. According to estimates made by the Council for Economic Planning and Development, R.O.C., by the year 1987, the total number of operators in sheet metal related occupations was 32,300 persons, with an estimated demand of approximately 1,600 employees. On the other hand, graduates from sheet metal related departments numbered about 600 persons, and some of them entered colleges. It is estimated that the sheet metal industry will become more important in the future and will become one of the most important industries in the automation era.

Since the sheet metal industry includes many occupations, is it necessary that it become one of the departments under mechanical cluster, or should it become a cluster by itself? Or perhaps should it be only a training unit under a specific occupation? All of these topics have been debated by teachers, industrialists, and curriculum specialists for years. It is apparent that many complaints and recommendations have been made by vocational/technical educators since the new curricula were implemented three years ago. This indicates that the curricula have some problems, the most significant of which are what knowledge students should study, what skills they should acquire, and what experiences they should have. Considering and answering these questions will influence the development of the Taiwanese economy, as well as the career development of individuals.

It is therefore important to establish a research model to investigate the competencies required by the sheet metal industry and to test the curriculum structure against it. The current study will use a needs assessment process to compare the competencies expected within the sheet-metal industry to the skills acquired in industrial/vocational senior high schools in Taiwan.

Purpose of the Study

One goal of education is to make learning experiences useful for attaining various types of objectives. Since learning experiences must be put together to form some kind of coherent program, it is necessary to organize learning experiences into units, courses, and programs. Ralph W. Tyler (1949) notes that:

> In considering the organization of learning experiences, we may examine their relationship over time and also from one area to another.... These two kinds of relationships are referred to as the vertical and the horizontal relations. There are three major criteria to be met in building an effectively organized group of learning experiences. These are: continuity, sequence, and integration. Continuity refers to the vertical reiterating of major curriculum elements.... Sequence is related to continuity but goes beyond it. Sequence as a criterion emphasizes the importance of having each successive experience build upon the preceding one but to go more broadly and deeply into the matters involved.... Integration refers to the horizontal relationship of curriculum experiences.... The organization of these experiences should be such that they help the student increasingly to get a unified view and to unify his behavior in relation to the elements dealt with. (p. 85)

In order to organize the curriculum for the sheet-metal department in industrial/vocational senior high schools, it is necessary to consider the vertical and horizontal relationship. In regards to the vertical aspect, depth--which emphasizes continuity-- the skills and knowledge needed by skilled workers each occupation will be considered. Different occupations in the same trade family may require different depths of skills and knowledge although they are concerned with the same operations.

Regarding the horizontal aspect, breadth or the integration of all occupations and/or operations will be considered. During their limited time in school, what should students learn for the sake of obtaining employment? For example, do students need to study courses in metal materials, wood working, or cooking?

As Tyler explains, the vertical and horizontal aspects are connected by sequence. In the sheet metal department, students develop more complex skills and knowledge, as well as better understanding of different occupations included in the sequence. The curriculum developers also need to consider what operations overlap between occupations. For example, brazing is one of the operation content of both auto-body repair occupation and industrial pipe occupation. These two occupations can be viewed as part of the same trade family. For another consideration, if brazing can be referred to as difficult and an important operation, provision for repeated practice by students should be planned within the curriculum design.

Objectives of the Study

The objectives of this study were:

1. To identify the occupations involved in the sheet metal industry in Taiwan and the relationships among them,
2. To identify skills and knowledge pertaining to the sheet metal industry that are taught in industrial/vocational high schools in Taiwan,
3. To identify occupations available for students graduating from the sheet metal departments of industrial/vocational senior high schools in Taiwan,
4. To identify curriculum development trends in the sheet metal department, and
5. To develop a research model for educational administrators of the government to use in investigating training needs of other industries.

Questions of the Study

Questions considered in the study were:

1. Between teachers, skilled workers, and supervisors in the sheet metal field, are there different opinions regarding skills and knowledge?
2. Are there different skills and knowledge requirements among sheet metal related occupations?

3. Are there different levels of complexity of knowledge among sheet metal related occupations?
4. Are there different emphasis on particular skills and knowledge related to sheet metal industry that are taught among industrial/vocational high schools?
5. Are there different skills required by employees among sheet metal related industry, compared to those that are taught in schools?
6. Is there different knowledge required within sheet metal related industry by employees, and what is taught in schools?
7. Is there any skill or knowledge trend within sheet metal related industry?

Hypotheses to be Tested

This study tested the null hypotheses listed below:

1. No significant differences in skill breadth will be found among the occupations related to the sheet metal industry.

   Ho: u1 = u2 = u3 = u4 ...

   where 1, 2, 3... = occupations
2. No significant differences in knowledge requirements will be found among the occupations related to the sheet metal industry.

Ho: u1 = u2 = u3 ...

where 1, 2, 3 ... = occupations

3. No significant differences in skill difficulties will be found among the occupations related to the sheet metal industry.

Ho: u1 = u2 = u3 ...

where 1, 2, 3 ... = occupations

4. No significant differences in skill difficulties will be found among skilled workers and supervisors in the sheet metal industry and teachers in industrial/vocational senior high schools.

Ho: u1 = u2 = u3

where 1, 2, 3 = teachers, supervisors, and skilled workers,

5. No significant differences in skill breadth expectations will be found between the sheet metal industry and courses in industrial/vocational senior high schools.

Ho: u1 = u2, u2 = u3, u3 = u4 ...

where 1, 2, 3 ... = occupations

6. No significant differences in knowledge will be found between skilled workers and supervisors in sheet metal related occupations and courses in industrial/vocational senior high schools.

Ho: u1 = u2, u2 = u3, u3 = u4 ...

where 1, 2, 3 ... = occupations

7. No significant opinion differences will be found in the correlation coefficients among different kinds of skills.

   Ho: $p1 = 0$, $p2 = 0$, $p3 = 0$ ...

   where 1, 2, 3 ... = skills and

8. No significant differences in knowledge opinion will be found among skilled workers and supervisors in sheet metal related factories and teachers.

   Ho: $u1 = u2 = u3$

   where 1, 2, 3 = teachers, supervisors, and skilled workers

Assumption of the Study

The following assumptions have been made in the design of this study:

1. The common courses, fundamentals courses, and selective courses in Curriculum Standard of R.O.C. are necessary. This study only dealt with the sheet metal related courses and skills.
2. The respondents accurately represented the tasks they performed.
3. The respondents and companies for whom they work are representative of persons and companies that did not participate in the research.

4. The respondents recognize sheet metal competencies which were taught in schools and required in industry.
5. The Educational Objectives announced by the Ministry of Education for the sheet metal department are adequate to make students employable at the entry level.

Delimitations of the Study

The following limitations have been made in the design of this study:

1. The competencies proposed in this study are meant for the three domains of learning: psychomotor, cognitive, and affective. The affective domain is considered to be closely linked with the other two domains. In this study only two domains, namely the psychomotor and cognitive, were surveyed.
2. The results of this study are generalizable only to the sheet metal industry in Taiwan.
3. The sample was drawn from the following groups:
   a. All teachers of sheet metal departments in industrial/vocational senior high schools in Taiwan.
   b. Skilled workers and supervisors who graduated from sheet metal departments in industrial/vocational senior high schools and were working in sheet metal

related factories.

4. The competency scope of the sheet metal related occupations in this study was drawn from "sheet metal related courses and skills" announced by the Ministry of Education, R.O.C.

Outline of Procedure

The research procedure was as follows:

Select a research problem.

1. Identify the broad research area that is most closely related to one's professional goals.
2. Locate specific problems within the scope of of the researcher's interests through a systematic research program.
3. Consult with one's major professor.
4. Decide on a specific research problem.
5. Prepare the tentative proposal.

Review the related literature.

1. List key words.
2. Checking primary sources (ERIC, Dissertation abstract, ISU thesis).

Write the purpose of the study.

Formulate the hypotheses.

Describe the research subjects.

Describe the tentative research.

1. Research techniques.
2. Source of data.
3. Method of securing data.
4. Limitation of technique.

Finish the research proposal.

Develop the questionnaire.

Prepare pilot study.

1. Conduct pilot study.
2. Revise the questionnaire.

Administer the questionnaire.

Gather the research data.

Process the research data.

Write the dissertation.

Definition of Terms Used

The following definitions were presented to aid in communication of the topics presented in the study.

Clustering: A number of similar things grouped together in association or in physical proximity.

Cluster family: Occupations that are logically related to one another through the similarity of task performed, concepts employed, or services provided by persons who functioned as a part of these occupations.

Common courses: The courses which were announced by the Ministry of Education, R.O.C. are general for all students. Therefore, all students should take those courses during the school years, for instance, English, Chinese, Physical Education.

Curricula Standards: A standards which include educational purposes, educational objectives, outline of subjects, and credits of subjects announced by Ministry of Education, R.O.C. All teachers or administrators should implement this curricula standards in developing curriculum.

Fundamental courses: The courses which were announced by the Ministry of Education, R.O.C. are fundamental in industrial/vocational high school level. All students of this level should take those courses such as Physics, Chemistry, Introduction of Computer.

Sheet-metal related courses: The courses which were announced by the Ministry of Education, R.O.C. are offered for the students of Sheet metal Department in industrial/vocational high schools. All students who study in this specific department should take these courses.

Sheet metal related industries: Industries in which the sheet metal skills are performed by skilled workers, and tasks are similar among the industries, such as ship building industry, air-conditioning industry, and metal furniture industry.

Sheet metal related occupations: Occupations in which sheet metal skills and knowledge are employed to perform those jobs. In this study the sheet metal related occupations are welding, auto body repair, piping, plumbing, platemetal forming, furniture making.

CHAPTER II. LITERATURE REVIEW

In this chapter, the literature and previous research related to the present study are reviewed. Broadly, the review focused on the following:

1. Curriculum development theory;
2. Curriculum development of vocational education;
3. Occupational clusters for vocational education;
4. Competency based vocational education; and
5. Summary.

A discussion of how the literature reviewed relates to the present study and a summary of the review are provided toward the end of the chapter.

Curriculum Development Theory

Curriculum theory

The search for ways and means of making educational programs more effective and meaningful has been an important preoccupation of illustrious educators over many decades. Effects have ranged from creating curricula that are child-centered (Dewey, 1940; Kilpatrick, 1983) and humanistic (Peters, 1981) to practical considerations in curriculum building (Tyler, 1949; Taba, 1962; Schwab, 1978). Consequently, the curriculum field appears replete with prescriptions on how to translate curriculum policies into functional programs. Although this seems to be a healthy situation for the field, Short (1983) explained that the existence of multiple forms of curriculum development is due to the fact that

> ... curriculum decisions, unlike those in the technologies associated with natural science, are not governed by fixed variables and regularity in their interactions but are largely matters open at every step to social and moral choice. (p. 44)

Implicit in Short's statement is that curriculum development in value-based and lacks the kind of objectivity characteristic of the physical sciences. This point of view is shared by Islam (1985) who suggested that the curriculum developer's beliefs and the assumptions he or she makes about the curriculum determine the curriculum approach to be adopted.

Rather than be guided blindly by personal values and interests, most curriculum experts (e.g., McCutcheon, 1982; Beauchamp, 1982; and Vallance, 1982) seemed to agree that curriculum development should be grounded upon defensible theories. As Tanner and Tanner (1980) indicated, "Practice in the absence of theory has limited applicability to wider and novel conditions ... theory is in the end the most practical of all things" (p. 96). A need for the development of theory and practice together exists and that good practice and good theory are interdependent. Therefore, Pierce stated (cited in Beauchamp, 1961) that "Field experience should be the chief basis both for the application of established theory and the development of new theory" (p. 21).

McCutcheon (1982) also defined curriculum as " ... an integrated cluster of sets of analysis, interpretations, and understandings of curriculum phenomena" (p. 19). The author suggested that a curriculum theory should meet certain criteria:

1. It should be open to challenge, both in terms of evidence supporting the theory and in terms of the line of reasoning -- how the analysis, interpretations, and understandings are assembled, juxtaposed, ordered or strung together. In other words, researchers must be able to refute or support the theory through studies; otherwise, the work is not a theory.
2. It must be based upon a strong value base, and must draw from multiple disciplines.

McCutcheon (1985) noted that there was a big gap existing between theory and practice in curriculum work. To narrow the gap, there were a great deal of problems: problems of what to teach; how to organize it; how to engender continuity, integration, and coherence in curriculum; how to discern what is being learned in classrooms; how to write materials that people can and will use; how to develop theories that are appropriate and significant in facilitating our understanding of curriculum matters.

In the study of psychological theory, David Bohm (cited in Wolfson, 1985) stated:

> ... a theory is primarily a form of insight, i.e. a way of looking at the world, and not a form of knowledge of how the world is ... all theories are insights, which are neither true nor false but, rather, clear in certain domains ... When we look at the world through our theoretical insights, the factual knowledge that we obtain will evidently be shaped and formed by our theories. (p. 53)

Although a number of instructional technologists and designers extended curriculum theory into practice, scientism is still the major approach to curriculum work in the actual planning of school curriculum. Macdonald (1977), from the viewpoint of scientism, suggested that there are three types of curriculum theory:

1. control,
2. hermeneutic, and
3. critical.

He explained that control theories focus on practice. The curriculum development process of control theorists is based on the linear-expert model. That is curriculum development begins with specific goals, moves to content and learning activities, and culminates with evaluation. Hermeneutic theory emphasized ideas and thoughts. Hermeneutic theories provide new viewpoint, perspectives, and interpretations of the human condition. Critical theory deals with both perspective and practice, with both understanding and control. Critical theorists focus on the dialectical relationship between theory and practical.

Where is the curriculum thinking going? Hunkins and Ornstein (1988) recognized that curriculum design involves various philosophical or theoretical issues as well as practical issues. A person's philosophical stance will affect his or her interpretation and selection of objectives. They stated, in practice curriculum designs are modification and/or integrations of three basic types: subject-centered, learner-centered, and problem-centered. In the same situation Arthur and Christine (1987) indicated:

> ... there is an ideal curriculum that scholars, critics, or pundits think we should follow; a formal curriculum that is written by some controlling group, usually at the state or local level, which promulgates the expectations and values of citizenry; a perceived curriculum that includes what teachers actually teach as they interpret the formal, written curriculum through their personal values and attitudes; an operational curriculum, the one that can be observed in the classroom; and the curriculum that is actually experienced by students. (p. 2)

From the viewpoint of historical perspective, Tyler (1987) also observed that many superficial changes and passing fads in curriculum have been instituted, but only a few substantial changes have taken place. He stated that some curricular reforms should be done from a historical perspective. He commended the curriculum improvement project of Eight-Year Study (1933-1941) of the Progressive Education Association which was highly successful. He suggested:

> What was noteworthy about this project was that each school was responsible for developing and operating a curriculum that was designed to help its students learn what they needed to learn to be responsible citizens, to be effective college students, and to assume occupational responsibilities. (p. 16)

Tyler emphasized that to reform the curriculum, the curriculum should be thought of and defined in terms of its educational aims or purposes and by content and teaching-learning procedures consonant with these purposes.

Curriculum development

Curriculum development, when broadly defined, covers the process of analyzing and refining goals, aims and objectives, together with the translation of these into content of courses by formal or an informal method. Historically, there are two main approachs to curriculum development (OECD, 1975). There is the "traditional" pattern. Development tasks are shared between the public authorities, teachers, examining bodies and universities which establish the curriculum outlines; the commercial publishers and free-lance writers who produce the teaching materials. The second pattern is what we call "heuristic" curriculum development, which originated in the United States in the late 1950s and which borrowed from the engineering and defense industries. Certain patterns and procedures were established -- the project method; the discovery approach; and the field -- testing of learning materials in trial schools. In the last decade, the systems approach have been supplemented. Most of the patterns were supplemented because the pilot studies, field testing and evaluation have provided through the feed-back processes valuable adjustments generated by national inspectors or local advisers.

Forms of curriculum development can be grouped and classified in a variety of ways. Klein (1986) believes that most curriculum scholars have advocated three most commonly school curricula: subject-centered; societal-centered; and individual-centered. Based on the needs of organization reform in educational system or needs to improve the quality of learning, the Center for Educational Research and Innovation of OECD (1975) labels two categories: system-based and subject-based curriculum development. For the same concept, Tyler identified three data sources which must be used in curriculum development: society, student, and subject matter. These three data sources have historically stimulated alternative conceptions of curriculum and the development of different curriculum designs. The importance of the three data sources have been long recognized by curriculum developers. A comprehensive curriculum must use all three.

Tyler (1949) clarified and amplified the scientific view of curriculum by identifying four fundamental questions concerning curriculum development.

1. What educational purposes should the school seek to attain?
2. What educational experiences can be provided that are likely to attain these purposes?
3. How can these educational experiences be effectively organized?
4. How can we determine whether these purposes are being attained? (p. 1)

Based on the scientific view of curriculum development from Tyler, Taba (1962) developed a more explicit model. The Taba's model consisted of seven steps:

1. Diagnosis of needs,

2. Formulation of objectives,
3. Selection of content,
4. Organization of content,
5. Selection of learning experiences,
6. Organization of learning experiences, and
7. Determination of what and how to evaluate.

Goodlad (cited in Molnar and Zahorik, 1977) placed greater emphasis on values as a primary curriculum decision than did Tyler. He identified three main elements:

1. values,
2. educational aims, and
3. learning opportunities.

Tyler's view of curriculum have also been extended by instructional technologists. Popham and Baker (1970) advocated a goal-referenced model that consists of four elements:

1. specification of objectives,
2. pre-assessment,
3. instruction, and
4. evaluation.

Hunkins and Ornstein (1988) also suggested four components of curriculum design: what is to be done? what subject matter is to be included? what instructional strategies, resources, and activities will be employed? and what methods and instruments will be used to evaluate the results of the curriculum?

From behavioral psychology, David Bahm (cited in Wolfson, 1985) insisted that insights which are often reflected in the work of curriculum planners include:

1. Reward, or immediate feedback, is necessary for learning to occur.
2. Learning proceeds by building from simple behaviors to more complex combinations of behavior.
3. Learning tasks should be presented in an ordered sequence.
4. Skills are hierarchical.
5. Desired performance should be specified in advance.
6. Repetition and practice are important to produce learning. (p. 55)

For Doll (1986), however, curriculum development can be classified into five divisions:

1. Subject designs, which stress content matter.
2. Social activity designs, which highlight social and community issues.
3. Competency designs, represented by behavioral descriptions and emphasis on subjectives.
4. Interest designs, based on the needs and interests of students.
5. Process designs, which emphasize learning how to

learn and thinking skills.

Johnson and Taylor (1974) indicated that there are three major categories of decision in educational planning: (1) what is to be taught; (2) why it is to be learned; and (3) how it is to be taught.

However, Newmann (1988) stated that most of the school curricula tend to focus on two general questions. First, are students studying the proper content? Second, what are the best ways to organize and teach a given body of content to certain groups of students? He asserts "regardless of what we teach or how we teach it, we try to teach too much" (p. 346).

Concerning the first question, the right number of courses in each content area and the blend of knowledge, skills, attitudes and values were asked. The task confronting the curriculum developers involves more than just accepting one curriculum design. It also requires consideration of horizontal and vertical relationship of the various curriculum elements.

In designing a framework of curriculum development Hunkins and Ornstein (1988) stated:

> Horizontal organization engages the curriculum worker with the concepts of scope and integration, that is, the side-by-side arrangements of curriculum components. Scope specifically deals with the breath and depth of content. Integration emphasizes the "blending" of various content topics and themes so they become new units, new topics. In part, it is an attempt to

> interrelate content with learning experiences and activities to ensure that students' needs are met. Vertical organization centers on the concepts of sequence and continuity. Sequence is the arranging of currcular elements through some particular logic - either psychological principles, social traditions, or internal logic of the subject matter itself. Continuity deals with the vertical manipulation or repetition of curriculum components. (p. 52)

The Centre for Educational Research and Innovation (1975) of OECD also indicated that fragmentation and continuity, are unresolved questions in curriculum development.

For organizing learning experience into units, courses, and programs, Tyler (1949) said "we may examine their relationship over time and also from one area to another" (p. 84). These two kinds of relationships are referred to as the horizontal and vertical relations.

Curriculum concepts that deal with both vertical and horizontal relations are balance and articulation. Hunkins and Ornstein (1988) indicated "Balance refers to assigning the appropriate weight to each aspect of the curriculum design" (p. 52). They said "A balanced curriculum is one in which students have opportunities to master knowledge and to internalize and utilize it in ways that are appropriate for their personal, social, and intellectual goals" (p. 52).

They also explained the meaning of articulation:

> Articulation refers to the vertical or horizontal interrelatedness of various aspects of the curriculum. Vertical articulation sequence to lessons, topics, or

> courses appearing later in the program's sequence.... Horizontal articulation refers to the association between or among elements occurring simultaneously. (p. 54)

Ornstein (1988) recognized that the picture of irrelevant curriculum raises questions about the way we organize the curriculum. He emphasized the educator should identify the context of the curriculum. In designing the curriculum educators should be concerned more with the process than products.

Curriculum Development of Vocational Education

Manpower training in vocational education

Most of the educators believe that the basic objective of the vocational education is to pursue an occupation which requires the ability to be employed in the world of work. Evans and Herr (1978) stated that there are three basic objectives in any public vocational education curriculum. They are: (1) meeting society's needs for worker, (2) increasing the options available to each student, and (3) serving as a motivating force to enhance all types of learning. Finch and Crunkilton (1984) noted that the vocational and technical curriculum has certain characteristics that distinguish it from the rest of the educational milieu. Each of these characteristics is associated with other curricula (e.g., general or academic). They represent the potential parameters of any curriculum that has as its controlling purpose the preparation of persons for useful, gainful employment.

Choate (1986) said "the economy of the United Stated is undergoing profound structural shifts. The decline of basic industries and the rise of new ones, the emergence of fierce foreign-based competition, record trade deficits, and displacement of millions of U.S. workers are only the most visible signs" (p. 85).

He recognized that preparing workers for the jobs of 1990s and 2000s, will be a formidable national task. A task of this magnitude demands the creation of a comprehensive strategy that has the participation and support of both the public and private sectors. Such a strategy is likely to require changes not only in present state and local practices, but in federal employment and training policies as well.

Choate recognized that four key structural changes are transforming the world economics: demographic shift, the growing significance of trade and investment, advancing technology, and the quickening pace of change. All factors mentioned above will decide the tendency of manpower development.

The demand for workers in various occupations is determined chiefly by the occupational employment needs of work organizations. These in turn are influenced by such matters as the general economic situation, scientific and technological development, and defense needs. Occupational careers depend upon the existence of sufficient number of new employment opportunities to provide jobs for new entrances to the world of work and for those displaced through technological developments.

As mentioned above, avoiding to become structurally unemployed, accept lower-paid jobs and be in less favorable working condition, workers should be technologically competent.

According to the research of the Organization for Economic Cooperation and Development (OECD, 1986), many factors affected the structurally unemployed. Available data for the United Kingdom, for instance, the structural unemployment had been affected by the economic prosperity prior to the oil crisis. After the oil crisis, the data showed a marked slow down in the economy.

Thus, vocational education and training appear to be at the center of the transition process for young people: It can be a positive force to develop a career pattern.

Education and training have an important role in preparing young people and adult workers for good citizenship, for self-development, and for meeting the nation's job opportunities. There is a close connection between the strength of educational system and economic growth. The 1984 vocational education law calls for action to provide vocational education services to train, retrain, and upgrade employed and unemployed workers in new skills for which there is a demand. The law provides for training and retraining in high-technology programs to help displaced and dislocated workers and calls for better coordination of Job Training Partnership Act programs and vocational education.

The Comprehensive Employment and Training Act of 1973 lays the foundation for a real beginning in manpower planning. The Act not only decentralizes decision-making with respect to manpower programs, it mandates manpower planning.

According to Kruger (1975) a most important value of manpower planning is that it is an educational process. Manpower planners can play a major role in improving the socioeconomic climate of their communities.

As recognized earlier, the manpower planning for vocational education, Hopkins (1975), who is coordinator of planning for the Oklahoma Department of Vocational and Technical Education, said that:

Several things can be gained from this approach.

> First, it takes the human judgment out of planning. Second, it allows planners to take a particular population and match it. Third, it allows manpower a profile of potential workers within a geographic area that would be suitable to the industry. Fourth, it provides the vocational decision maker at the state level with information concerning the capital investment for facilities, equipment, and operation needed in order to meet the needs of business, industry, and the population of the state. (p. 45)

Fraser (1986) recognized that in the national effort to strengthen job training opportunities for dislocated workers, disadvantaged workers, young people entering the work force, and indeed, all workers, both employed and unemployed, it is clear to us in the labor movement that unions should face a key role. The experience and input of labor union people can help assure that training is realistically geared to the labor market so that workers do not go through training only to end up unable to find a job.

Kistler (1975), who was president of Human Resources Development Institute, ALF-CIO, Washington, D.C., recognized it is virtually impossible to predict with accuracy what skills today's high school seniors will need five, ten, or twenty years hence, since national economic trends, local industrial growth or cutbacks, technological change, the geographic mobility of young people, and even the desire of many people for mid-career changes, all affect the marketability of their skills.

He suggested that:

> Vocational education system must be flexible enough to respond to the shifting needs of those it serves. There are two sides to the problem of providing workers with skills that are in demand: (1) developing training relevant to known employment needs and trends enabling the young to enter the labor market; and (2) providing opportunities for experienced workers to update their skills as new needs arise. (p. 36)

He also suggested that vocational educators should work hand in hand with local labor unions, because local labor unions know where the jobs are in their community, what kind of training a young person needs to qualify, and what tools or machinery are in current use. Union leaders are knowledgeable about changing employment trends, skill requirement, and technological developments.

In many parts of the country, labor organizations are actively assisting teenagers to gain entry into the labor market through programs of their own, some supported by union trust funds, others by outside sources such as the Comprehensive Employment and Training Act. There is room for much greater coordination between school and labor than currently exists.

Kistler (1975) said that:

> Establishment of a forum for the interchange of ideas among educators, labor representative, businessmen, counselor, and other groups with ideas on vocational training needs should be the first step. Local advisory councils on vocational education should be created or strengthened to provide this kind of exchange.... Under the Comprehensive Employment and Training Act, vocational education should also be attuned to activities of state and local manpower advisory councils. (p. 74)

Choate (1986) stated that

> Nationally each year between now and 1995, over 1 million persons will enter the work force for the first time. An equally large number of persons will reenter the work force. Most will require some entry level training either on the job or before they begin work. (p. 97)

He also said that:

> Today, over 16 million students are enrolled in the nation's 27,650 public and private vocational training institutions for some period of time each year. The training they are offered appears to be influenced more by the capacities of the institutions to deliver the training than by the needs of the economy and specific employers. This is a sure-fire formula for missed opportunities, personal disappointments, and economic stagnation. (p. 97)

He recognized that if this training is to succeed in helping workers develop the skills they will need in the years ahead, four basic actions are now appropriate: (1) labor-market information must be improved; (2) instructional equipment must be modernized; (3) faculty and counselor skills must be updated; and (4) programs must be linked to the needs of employers. These are key ingredients of a flexible training system capable of adapting to shifting economic circumstances.

Vocational education can be defined as the formal process developed in a society to prepare the citizen for a work role. Copa and Irvin (1975) stated that the several assumptions underlying this definition are as follows:

First, the filling of a work role is an important source of satisfaction to both the individual and society. Second, a major purpose of vocational education is to prepare individuals for employment in such a way that the highest level of satisfaction will be reached for both the individual and society. Third, vocational programs constitute a viable force in influencing the quantity and quality of occupational supply, but is only one of several such forces. Fourth, vocational education is a broad concept covering a variety of formal means of preparing people for work-in-school programs, apprenticeship, on-the-job training, and others.

As mentioned earlier, occupational supply and demand information is useful for deciding what the output of the vocational program should be rather than the input to the program. Since vocational programs may vary a great deal in cost per unit of output, final decisions about the size and nature of the output and the input required can be made only after total resources and cost per unit of output are defined and the implications of many other types of information are considered.

Constructing the curriculum for manpower development

Poland (1975) recognized that manpower planning is one of the most important forces affecting curriculum design in vocational education. In finding and closing the gaps between manpower planning and curriculum construction, he stated the curriculum designer must be cognizant of current public resources, current and future job trends, and the means and methods available for curriculum construction.

Ohanneson, who was director of vocational education office of the Santa Clara County Superintendent of schools, San Jose, California, and Clenn Vanghan collected data from more than 150 occupations in Santa Clara County concerning both occupational supply and demand. The occupational demand information was provided by the State Employment Development Department, which released detailed area manpower requirements for 400 key occupational categories. The state employment data for each occupational category reflect (1) current employment, (2) anticipated industrial growth, and (3) personnel replacements. For any specific occupational cluster, supply can be subtracted from demand to determine the Net Training Need. District vocational planners can feed net training need data on any or occupational clusters to occupational advisory committees to help them in the selection, review, and evaluation of programs (Ohanneson & Vanghan, 1975).

Ohanneson noted that this type of quantitative information was gathered on more than 150 training programs in the county, and has been used in the following ways:

* To determine local needs for both vocational and manpower programs.
* To determine occupational categories for which mini surveys are needed.
* To set priorities for Regional Occupational Programs.
* To provide more up-to-date inservice information for counselors.
* To provide career information of a more specific nature for students and parents.

Copa and Irvin (1975) used the opinion of culture compromise to explain the relationship between manpower and curriculum in vocational education. They stated:

> Vocational programs have their major impact on occupational supply, but the objective is still to maximize the mutual satisfaction implies a need for some correspondence between supply and demand. Individuals cannot derive satisfaction from working if they don't have job, and society can not benefit from output if jobs go unfilled. In these circumstances, the most useful occupational demand information would seem to be proportional distribution of total demand across specific occupations or occupational groups. (p. 41)

Attempting to analyze the curriculum construction in vocational education through the viewpoint of manpower planning is necessary.

Constructing the curriculum

Once the manpower needs, goals, and objectives have been established, the curriculum designer is ready to begin construction of the curriculum. Poland (1975) recognized that one of the best methods of determining the elements that should go into the learning program is to conduct a job analysis. He indicated that a random sample of jobs in the occupational cluster to be taught will produce information such as the following:

* Job identification facts (job title, location of jobs, number of employees, sex of employees, salary, working hours, miscellaneous job facts).
* Skill requirements (educational requirements, job experience, relationships to other jobs, job duties, job knowledge).
* Responsibilities (direction and group leadership, office/store operation, care of equipment, safety and health of others, contact with the public).
* Effort demands (physical activities and worker characteristics).
* Working conditions (specific conditions, hazards).

With this information in hand, the designer determines the step-by-step sequence in which the material will be introduced in the instructional schedule.

A task analysis should be undertaken to provide the framework for instructional strategies. Poland (1975) stated:

> The task analysis will enable the designer to distinguish between "what actually is" and "what was" and "what might be nice". To supplement his own task analysis, the designer should review studies such as the New Office and Business Education Learning System for nationwide task analyses of office occupations. (p. 52)

Selecting program pattern

Having gone through a manpower planning process which includes job analysis, task analysis, and research, the curriculum designer is ready to determine the program--which element of instruction should be placed where and in what order, and which program pattern will be most effective.

Instructional strategies--learning activity packages, simulations, multi-media materials, projects, field experiences, and others--can be developed to teach the specific concepts, knowledge, and skills required for the occupational area. Instructional strategies can also be developed for occupational information and job exploration within each cluster.

One of the most practical curriculum development models have been developed by International Training and Education Company. It is based in an Instructional Systems

Development Approach for curriculum development. The foundations for instructional materials are four central concepts: performance-based, competency-based, highly-illustrated, and programmed instruction. Petty (1984) also identified that the pattern of vocational curriculum must be a formidable foundation. That foundation must be constructed of the various competencies that make up the various tasks.

In conclusion, pattern of curriculum development are based on (1) competency-based, (2) performance-based, (3) specific objectives, (4) detailed instruction, (5) highly-illustrated, (6) instant evalution, (7) criterion-referenced, and (8) competency profile.

Generating information

As Kruger (1975) points out, the manpower planning process, in itself, generates information. By the time the curriculum designer has completed the process of manpower planning and subsequent development of a business and office education program, he has collected a sizable body of information, much of it is useful for evaluation purposes. To supplement and support this information, the curriculum designer or educator can survey businessmen, educators, and students to further determine the source of workers, preparation and placement of workers, hiring practices, turnover, and other employment factors. On the basis of this information, the curriculum can be judged on its service to clients and its contribution to the overall manpower planning system of the state or community.

Cluster Curriculum for Vocational Education

Before the topic of occupational clusters is discussed more adequately, it may be helpful to provide a definition of the term. Weagraff (1974) provided this definition:

> ... the cluster concept is an organizational approach which is directed toward the preparation of individuals with skills, knowledge, and attitudes required for entry into a family or cluster of occupation. (p. 47)

Cunningham (1969) suggested that such an organizational approach can be readily applied to curriculum planning:

> When we speak of grouping jobs or occupations for educational purposes, we are assuming that jobs within a given cluster are similar in the sense that certain core educational experiences could be established which would facilitate the learning or performance of all jobs within the cluster. (p. 20)

Occupational clustering enables the curriculum developer to build a generalized instructional base which can be used to prepare learners for a number of initial jobs rather than training a person in-depth for a specific job. Smith (1979) produced research in which a questionnaire was administrated to trade persons, supervisors, technicians, technologists, and trade helpers to determine which skills are used in work performance. The results of the research indicated a number of trade families were identified, the basis of skills used in work performance was classified, and also the skill requirements for each of the trade families was identified.

Wolansky and DaVall (1982) stated:

> There is an increasing demand for persons with appropriate employability skill and behaviors and job-related skill which require one or more years of formal preparation. Industry and schools ought to view their partnership as essential and beneficial to each other. (p. 3)

Dobry (1969) also focused upon the limitations of job analysis and specific training for a single occupation. She stated:

> The traditional approach of preparing students for single occupations tends to restrict their freedom in making occupation choices, overlook rapid change in the labor market, and limit mobility. (p. 56)

Venn (1978) also indicated, "The need of individuals and society have changed dramatically in recent years, especially in terms of work, the preparation for work and the relationship between education and work" (p. 71).

Wolansky and DaVall (1982) discovered that the effects of rapid technological changes and educational response to these changes have led to the renewed interest in redirecting the vocational education curriculum at the secondary high school level from specific job preparation skill to generalized skill with transferability to several jobs within an occupational family.

Arnow (1968) draws a similar conclusion:

> Whatever one concludes about the merits of broad versus (specific) occupationally oriented education, it is clear that occupational curricula offered at the high school and post high school levels should be expanded. These curricula should be based on the "broad cluster" concept, as a part of broad-based education, to permit both the opening of more options than are now available and the prospect of career ladders in these options. (p. 28)

In response to the needs of the development of high-technology workforce, Wolansky (1973) noted that schools must be responsible for providing vocational education students with a knowledge foundation which enables students to learn the high technology. He said that:

> The work of the future will be more knowledge based, then we, as educators, have a commitment to students to help them acquire a knowledge foundation in schools that will enable them to function in this important human activity of work. (p. 39)

Preparing high school students for a cluster of occupations rather than a single occupation, Wolansky and DaVall (1982) stated five reasons:

1. Technology, and the industries and occupations dependent on it, is rapidly evolving bringing about need for new skills, attitudes, and adjustments of personnel at all levels.

2. Educational systems ought to maximize transferability of skills and techniques in a broad cluster of related occupation.

3. Recognize individual differences.

4. Involvement in vocational education ought to extend over more years which enables a learner to discover and experience occupational activities.

5. Early specialization tends to reduce career options and may account for high student attrition. (p. 4)

Johnson (1984) recognized that there are five reasons for clustering occupations:

1. For studying labor market.
2. For planning and allocating training opportunities in line with possible developments in the labor market.
3. For showing young people that skills learned in one job can be used in another.
4. To economize in training by making the first part of the training common for occupations with closely related sills.
5. To delay a narrow choice on the part of a young person by making the first part of training common for a group of occupations.

From the view point of manpower development, in 1984 the Oregon Employment Division submitted a proposal to the Department of Education (Oregon Occupational Information Coordinating Committee, 1985a) to conduct a review of clusters used to organize the delivery of secondary vocational education in the State of Oregon. The proposal stated that the review would focus on issues related to

Oregon's current and projected labor market need, national occupational and industrial trends and the common skills and competencies which form the basis for organizing occupations and training programs into clusters.

The conclusion of the project suggested that the existing clusters are still strongly tied to the state's projected labor market needs. However, two existing clusters, Service and Electricity/Electronics, were subdivided to more closely relate instruction to industries. The report indicated that to meet the needs of manpower development occupational cluster curriculum which supports a broadly-based approach to providing students with entry level job skills, good basic skill and appropriate work attitudes and values is necessary. The report also recommended that educators should be given in-service education on revised clusters. Other recommendation was made for a more frequent continuing program of cluster revision to meet changing economic conditions.

Criteria for clustering content

Weagraff (1974) identified several basic requirements in his scheme for organizing occupational clusters.

1. Each cluster should include jobs at all levels, from entry-level through skilled, technical, and professional jobs. This range implies a logical career ladder that increasing levels of educational preparation and acquisition of more advanced skills.

2. Each cluster should be related to an identifiable group of employers.

3. The cluster should be enduring and important. (p. 48)

Wolansky and DaVall (1982) stated that "Other requirement also can be applied, such as grouping jobs which have common tasks or a system of basic principles, concepts, common skills, and prerequisite aptitudes" (p. 9).

Many methods can be used to identify cluster content. The task analysis approach utilized in Oregon Model (Oregon Occupational Information Corrdinating Committee, 1985b) identified occupations for which vocational training was necessary and grouped occupations which had similar task performance requirements. The example of metals vocational cluster includes five occupations: welder, machinist, foundry worker, auto body repairmen, and sheet metal worker. The Maryland Cluster Model (Maley, 1975) identified occupations by centering around a specific cluster. Each occupational area is taught as a separate unit without a great deal of effort to inter-relate the various areas. The example of construction cluster includes five occupations: carpentry, masonry, plumbing, electrical, and painting. The Maryland Cluster to Apprenticeship Model (Maley, 1975) has a vital part to play in a pre-apprenticeship role. The program leads to a more specialized and formal training program such as an apprenticeship.

Any content analysis in deriving a cluster must include functional skills, knowledge, and attitudes. Tasks that are common to several jobs or job groupings are then clustered into a core. The less common elements that are related to limited jobs within the cluster, form the peripheral content and may be organized into more specific courses within a vocational education program.

The policy of moving away from teaching specific job skill for single jobs to more generalized skills, knowledge, and attitudes as appropriate occupational requirements for entry level into a family of occupations seems to be defensible for secondary age students. Such a policy in curriculum redirection would enable students in vocational education secondary schools to make more realistic career choices, secure initial placement, and adapt in the work place. Exposure to a broad range of occupations would contribute not only to more realistic career choices, but also serve as a foundation for continued education and later specialization. Employment flexibility with changing job demands, mobility from one occupation to another in the occupational family, and transferability of skills are the major benefits of a cluster based curriculum.

Competency Based Vocational Education

Competency-based vocational education (CBVE) is a popular, widely accepted instructional approach for delivering vocational education. Numerous diverse definitions exist for CBVE (Knaak, 1977; Polk, 1982). Usually, these definitions are thought of as having the following as desirable characteristics of a competency based or task analyses; containing measurable objectives and criterion referenced assessment; and inclusion of ongoing program updates, input from the field, and credit for prior achievement.

Not all educators perceive the concept of competency-based curriculum in the same manner. Carpenter (1968) defined competency as "the ability to apply to practical situations the essential principles and techniques of a particular subject matter field" (p. 4). Another definition of competency is "ability (including knowledge, skills, and/or attitudes) to perform a specific task successfully to meet a specified standard" (Meyer, Moore, Steele, & Vaughan, 1986).

Crawford (1977) subdivided competence into knowledge, understanding, skill, and attitude and defined each as given below.

> Knowledge: The recall of specifics and universals, the recall of methods and processes and the recall

of a pattern.

> Understanding: The power to make experience intelligible by applying concepts and theories; the comprehension of ideas and the ability to use abstractions in particular and concrete situations.
>
> Skill: A rather high level of mental ability; the ability to use one's knowledge effectively and readily in execution of performances; the ability to analyze, synthesize and evaluate.
>
> Attitude: A mental position, a feeling or an emotion toward a fact or state; a predisposition to act in a certain way; a state of readiness that influences a person to act in a given manner. (p. 3)

To the above definition of skill, Staley (1971) added that tasks should be performed with more than usual proficiency and that skill be measured by quality of results and economy of effort.

The concept of competency based vocational education means different things to different people (Blank, 1987). Missouri Department of Elementary and Secondary Education (1984) defined as "occupational programs in which required behavior (competencies) and performance standards are specified in advance of instruction" (p. 4). Florida's Official definition is "instruction for employment that is based on current job tasks, which are made known to each student before instruction and which are to be performed by the student under prespecified conditions and according to prespecified standards" (Florida Department of Education, 1983). A definition offered by the Arizona Department of Education (1984) is "an approach to an instructional system which emphasizes the student developing and demonstrating specified (competencies) as measured by performance tests." Basically, all of these States definitions try to address four components: job competencies, sound instruction, required mastery of each competency, and the use of performance tests.

Fretwell (1987) defined the competency based vocational education as a systematic process for the following:

> 1. Identifying the specific level of skill and knowledge to perform a given occupation in the marketplace.
>
> 2. Tailoring instructional materials that will enable trainees to learn these skills at their own pace and in ways they learn best.
>
> 3. Preparing instructional staff to make effective use of this learning process.
>
> 4. Assessing student progress at each level of training activity and assuring that one skill is mastered before going to the next.
>
> 5. Updating and modifying the instructional materials as job needs change. (p. 48)

There are three concepts associated with competency-based curriculum. The first is that objectives are stated in terms of behavior and are measurable.

Accountability is the second concept. The student must accept responsibility for meeting the established standards.

The third characteristic is personalization. In competency-based instruction students can progress at an individual rate and they are allowed some choice in objective selection and learning activities (Houston & Howsam, 1972).

Howsam (1972) has used a model of three concentric circles to define competency-based instruction. In the model the inner circle is performance-based instruction and its four elements of precise behavioral objectives, performance criteria and criterion level, instruction pertinent to the criteria, and learner accountability in terms of the criteria.

The middle circle contains the enhancers. These are the means to implement performance-based instruction. Examples of enhancers are modularized instruction, instructional teams, use of technology, and multiple alternative learning opportunities.

The enablers are in the third or outer circle. Types of enablers are management by objective management; and effective teacher personnel procedures.

Palardy and Eisele (1972) recognized that in competency-based curriculum time is not as limiting a factor as it is in the traditional approach. In order to complete a course under competency-based instruction, a student must demonstrate that he has reached the established criterion level for each objective.

Competencies and behavioral objectives are directly related, and it is through behavioral objectives that competencies develop into instruction. After achieving several behavioral objectives, a student will be able to demonstrate a competency. According to this reference, competencies are stated in general terms and are course related.

According to Shane and Shane (1973), Tyler made the following definition of behavioral objectives:

> What I mean by behavioral objectives is a statement of what teachers are trying to help students learn from their instruction-the way of thinking, feeling, or acting that they want students to develop. (p. 42)

Miles and Robinson (1971) noted that a behavioral objective describes what the learner will be like after successfully completing a learning experience. It describes the pattern of behavior the learner will be able to demonstrate. A behavioral objective communicates a picture describing a successful learner.

Summary

The literature review has shown that a gap exists between theory and practice in curriculum development. This gap does not mean that curriculum experts have not tried to put curriculum theory into practice. But apparently, because of the nature of educational philosophy in curriculum design, most curriculum scholars have emphasized three different types of school curricula: subject-centered, societal-centered, and individual-centered. The curriculum development literature, therefore, is quite varied-- some authors have dealt with behavior science processes and others with subject content processes.

A vocational education curriculum must be able to meet the society's need for work and increase the options available to each student as well. On the other hand, technology has developed rapidly in the past decade also contributing to the need for curriculum revision. Curriculum models have also been proposed to replace the traditional clinical model for vocational education. But, in spite of all criticism, an abundance of evidence in the literature suggests that the curriculum of vocational education has failed to satisfy the needs of individuals and society for two probable reasons: First, alternative curriculum models such as the cluster curriculum faces sharp criticisms, and, in some cases, outright rejection because clusters have not been tied to the State's projected labor market needs. Second, the curriculum can not provide entry-level job skills and appropriate work attitudes and values to meet the changing economic conditions.

Another evidence in the literature also indicated that competency-based vocational education has exerted considerable influence on vocational curriculum development since its introduction in the 1970s. But, as noted earlier, not all educators perceive the concept of competency-based curriculum in the same manner. Basically, most experts address four components of this curriculum: job competencies, sound instruction, required mastery of each competency, and the use of performance tests.

The systematic process of curriculum development seems to be gaining much ground and does not appear to be the subject of too much debate or to be rejected among educators. Its place in vocational education programs suggests that this might be the dominant curriculum development model in the field of vocational education.

Finally, the recent introduction of a vocational education curriculum in Taiwan accounts, in part, for the limited availability of research in this field. However, the ineffectiveness of the existing vocational education curriculum, which is evidenced by a lack of qualified skilled workers spells the need for a systematically planned and developed curriculum in the country. Although the vocational curriculum models reviewed were developed outside of Taiwan, with proper adaptation, their basic tenets can be formulated in a systematic curriculum development procedure that will meet the needs of vocational education in Taiwan.

CHAPTER III. METHODOLOGY

The methods and procedures used in this study are described in this chapter and are reported in five parts:

1. A definition of the population and sample of the study.
2. A definition of the variables of the study.
3. Development of the instrument.
4. Method of data collection.
5. Method of data analysis.

Population and Sampling

The population of this study consisted of

1. All teachers of the sheet metal departments in industrial/vocational senior high schools in Taiwan. Thirteen such departments were identified from education statistics obtained from the Ministry of Education, R.O.C.

   A total of 78 teachers except for 8 who were not teaching in school this semester participated in the study.
2. All skilled workers and supervisors who were employed in this field. Both groups would have graduated from industrial vocational senior high schools and were

working in the sheet metal related occupations that were identified from the Dictionary of Occupational Titles published by the Bureau of Vocational Training, R.O.C. The sheet metal factories were identified from the Monthly Report of Labor Statistics, June, 1989, published by Executive Yuan, R.O.C.

The above population was identified and chosen for this study because skilled workers and supervisors have backgrounds both in high schools sheet metal education and in sheet metal work. Teachers were chosen because the competencies taught in industrial/vocational senior high schools represent the central issues of this study.

From the above population, the following samples were drawn:

1. Because of their small number, all teachers of sheet metal departments in IVSHS were included in the sample.
2. Fifty skilled workers from each sheet metal related industry were included. The total number of skilled workers was 250 subjects selected from five sheet metal related occupations, from a stratified sample of 73 factories.
3. Ten supervisors from each sheet metal related industry were included. The total number of engineers was 100 subjects selected from five sheet metal related

industries, from a stratified sample of factories.

Variables of the Study

Independent variables

The following independent variables were studied:

1. Teachers, skilled workers, and supervisors, who represent the nominal independent variables.
2. The persons who were working in sheet metal related occupations, such as general sheet metal working, welding, cold metal working, auto-body repairing, and industrial piping, were identified as the nominal independent variables.

Dependent variables

The following dependent variables were studied:

1. The value of perceptions in needed occupational skills, which serve as the interval dependent variables;
2. The value of perceptions in introductory needed courses, which serve as the interval dependent variables; and
3. The value of perceptions in advanced needed courses, which serve as the interval dependent variables.

Development of the Instrument

A questionnaire was developed for gathering data for this study. The questionnaire items were generated by the investigator. The instrument consisted of three parts. The first part was devoted to personal information which contains different items depending on the subjects (teachers, supervisors, and skilled workers). Second part dealt with the skill perception; and third part dealt with the knowledge perception.

The outline of the Curriculum Standard of Sheet-metal Department announced by Ministry of Education, R.O.C. was used as a starting point to develop the research instrument. Additional information was obtained from text materials for each occupational area and from competency based instructions used in the many States in the U.S. These resource materials were scanned to determine the types of skills/knowledge which the skilled workers might be required to perform in sheet metal industry.

All skills and knowledge were divided into constructed items. When items were completed, 47 skill items were employed within the second part; and 100 knowledge items were employed within the third part in the pilot questionnaire.

All items, except the personal information, required two responses per item. The first response indicated the perception of skills/knowledge which are currently taught; and second response indicated the perception of skills/knowledge which should be taught when graduates are employed.

A Likert-type scale was employed in order to measure the respondents' perceptions toward the value of items by teachers, skilled workers, and supervisors. Each response employed five scales. An individual's score on the scale was the sum of numerically coded reactions to the knowledge or skills.

A special jury of five sheet metal professors was formed. The professors were asked to evaluate all items. They were given a list of curriculur standards and asked to determine whether the listed items were inclusive of all of the knowledge and skills necessary in the sheet metal industry. They rated the appropriateness of each item on a scale of one through five. After adding up the score for every item, the one or two items receiving the lowest scores were deleted, and other items were revised according to the suggestions of the jury.

After the pilot study, 48 skill items were used in the second part; 99 knowledge items were included in the third part; and some of these items were revised.

A pilot study was employed in order to examine the reliability of the instrument. The special jury determined the content validity. Items with low reliability were revised. In sum, 147 items for each course were developed.

Method of Data Collection

The subjects include teachers, supervisors, and skilled workers who were employed in Taiwan during the Spring of 1990. The use of a mailed questionnaire was the method of data collection employed in this study.

The questionnaires were mailed out on December 25, 1989, to each person. The respondents were asked to return the completed questionnaire in a sealed envelop provided by the investigator before January 14, 1990. Postage was provided (see Appendix A).

Although the respondents were asked to return all questionnaires on time, out of 428 questionnaires sent out, 144 were returned after January 14. After following up by telophone, 284 questionnaires were returned by January 24, 1990. Except 21 were invalid, this represented 61.45% returned instruments which provided the data for analysis in this study. Table 1 shows the percentage of questionnaires returned from the three groups.

Methods of Data Analysis

The data from the returned questionnaires were coded on an IBM microcomputer in preparation for keypunching and subsequent computer analysis.

Responses to the articulation scale in the questionnaires were measured and studied in the following manner.

Using the computer proguam, Statistical Analysis Systems (SAS), total scores were obtained. Means and the standard deviations were obtained and different statistical tests were carried out to determine if there was a difference in the articulation total scores obtained from the responses. Each hypothesis was tested as follows.

TABLE 1. Number of questionnaire returned by group

Group	No. sent	No. returned	percent return
teachers	78	69	88.46
supervisors	100	59	59.00
skilled workers	250	135	54.00
Total	428	263	61.45

Hypotheses 1 & 3

An analysis of variance (ANOVA) using the General Linear Method (GLM) procedure in the Statistical Analysis System (SAS) package was used to test whether there were significant differences among the perception scores of persons whose jobs require different skills. If there was a significance, the Scheffé's Multiple Range test was used to test differences between groups.

Hypothesis 2

An analysis of variance (ANOVA) using the GLM procedure in the SAS package was used to test whether there were significant differences among the perception scores of sheet metal related workers regarding what aspects of their jobs require less or more knowledge. If results were significant, the Scheffé's Multiple Range test was used to test the significant difference between groups.

Hypotheses 4 & 8

An analysis of variance (ANOVA) using the GLM procedure in the SAS package was used to test if the perception scores among teachers, skilled workers, and supervisors had significant differences between different levels of skills. If the results were significant, the Scheffé's Multiple Range test was used to test the significant difference between groups at the .05 level.

Hypotheses 5 & 6

Student's T test was applied to test whether there were significant differences between the expectation scores in skills and knowledge of persons whose jobs were different.

Hypothesis 7

A correlation coefficient matrix of the responses regarding skills and knowledge was computed in order to indicate the overall trend of curriculum development.

CHAPTER IV. FINDINGS

In this chapter, the major findings of this study are presented. The presentation focuses on results of(1) the descriptive statistical analyses of some general characteristics of the sample, (2) the statistical tests of the null hypotheses relating to the questions of study, and (3) the analyses of other pertinent data concerning curriculum development trends in the sheet metal department in vocational/industrial high schools in Taiwan.

General Characteristics of the Sample

Composition of the sample

Two hundred sixty-three (263) respondents provided the usable data for this study. The composition of this sample is shown in Table 2, which indicates that 69 teachers, 59 supervisors, and 135 skilled workers participated in the study.

Occupations of the respondents

For the purposes of this study, respondents were classified according to seven occupational fields, namely, teacher, general sheet metal, auto body sheet metal, sheet metal plastic forming, platemetal cold working, welding working, and piping or plumbing. Table 3 shows the number

TABLE 2. Distribution of the respondents by group

Group	No.	%
1. Teachers	69	26.3
2. Supervisors	59	22.4
3. Skilled workers	135	51.3
Total	263	100

of responses received from subjects among each of the various occupations.

It should be noted that only three respondends were in the piping or plumbing occupation. Because of this limited number of respondents, statistical analysis would not be appropriate.

Table 3 indicates that 69 respondents (26.2%) were teaching sheet metal programs; 88 (33.5%) were working in the general sheet metal occupation; 35 (13.3%) were working in the auto body sheet metal occupation; 12 (4.6%) were working in the sheet metal plastic forming occupation; 29 (11.0%) were working in the platemetal cold working occupation; 27 (10.3%) were working in the welding working occupation; and 3 (1.10%) were working in piping or plumbing occupation.

TABLE 3. Distribution of the respondents by occupation

Occupation	No.	%
1. Teachers	69	26.2
2. General sheet metal	88	33.5
3. Auto body sheet metal	35	13.3
4. Sheet metal plastic forming	12	4.6
5. Platemetal cold working	29	11.0
6. Welding working	27	10.3
7. Piping or plumbing	3	1.1
Total	263	100

Consideration was given to the highest educational background attained by the respondents. This information is presented in Table 4. As Table 4 illustrates, 77 respondents had earned their bachelor's degree. Another 49 respondents had graduated from junior colleges. A total of 137 respondents had graduated from vocational/industrial high schools.

As a background for the major questions of this study, the perceptions of respondents were sought regarding which of the objectives listed in the questionnaire were actually taught in schools and which were needed to perform the respondents' current jobs.

TABLE 4. Highest educational background of respondents

Education background	No.	%
1. Bachelor's degree	77	29.3
2. Junior college	49	18.6
3. Voc/Ind high school	137	52.1
Total	263	100

Respondents were asked to rate, on a scale of 1 to 5, the level of competency required at the workplace for each item. Results of these analyses are presented in the responses to each of the research hypotheses.

Research Hypotheses

Null Hypothesis 1

It was hypothesized that no significant differences in the skill breadth were found among the occupations related to sheet metal industry. Table 5 shows the results of the means, standard deviations, and analysis of variance relating to skill breadth among occupations.

As shown in Table 5, there are significant differences in the skills of general forming, auto body working, arc welding, resistance welding, sheet metal pressworking, and cold metal working among the occupations.

Therefore, based on the results of analysis of data presented in Table 5 there was sufficient evidence to reject the null hypothesis.

TABLE 5. Means, standard deviations and ANOVA relating to the skill breadth among the occupations

	Statement	Overall Means	Std. Dev.	F-Value
1.	General forming (light gage sheet metal)	2.25	1.00	3.38*
2.	Development method	2.78	1.39	2.63
3.	Auto body working	2.87	1.35	15.01**
4.	Gas welding and cutting	2.80	1.10	2.38
5.	Arc welding	3.18	1.05	3.15*
6.	Soldering and brazing	1.90	1.09	2.02
7.	Resistance welding	3.02	1.63	8.34**
8.	Sheet metal pressworking	2.68	1.22	5.00**
9.	Basic bench working	2.64	1.35	0.49
10.	Cold metal working	2.71	1.32	5.58**
11.	Plumbing and piping	2.02	1.22	1.78
12.	Welding inspection	2.03	1.30	4.41
13.	Numerical control	2.44	1.48	2.43

*p<.05, **p<.01.

Scheffê's test for significant variables is shown in Appendix C.

Regarding the skill of general forming of light gage sheet metal, this information is included in Appendix C, Table 43.

There were significant differences between occupations in general sheet metal ($\bar{x}$=2.81) and arc welding ($\bar{x}$=2.02). This indicated that arc welding occupation emphasizes least the skill of general forming of light gage sheet metal.

Regarding skill of auto body working, this information is included in Appendix C (Table 44).

There were significant differences between 1) general sheet metal occupation ($\bar{x}$=1.91) and auto body sheet metal occupation ($\bar{x}$=3.74), 2) sheet metal plastic forming occupation ($\bar{x}$=1.85) and auto body sheet metal occupation, 3) platemetal cold working occupation ($\bar{x}$=1.92) and auto body sheet metal occupation, and 4) welding working occupation ($\bar{x}$=2.o4) and auto body sheet metal occupation. Obviously, skills in auto body working are emphasized most by the auto body sheet metal occupation workers.

Regarding the skill of arc welding, this information is included in Appendix C (Table 45).

There were significant differences between sheet metal plastic forming occupation ($\bar{x}$=2.23) and welding working occupation ($\bar{x}$=3.58). This reveals that the skill of arc welding is not so important for the sheet metal plastic forming occupation. As shown in the Table 45, most of the occupations did emphasize this skill.

Regarding the skill of resistance welding, this information is included in Appendix C (Table 46).

There were significant differences between 1) general sheet metal ($\bar{x}$=3.55) and plate metal cold working occupation ($\bar{x}$=1.89), 2) general sheet metal occupation and welding working occupation ($\bar{x}$=2.15), and 3) auto body sheet metal occpation ($\bar{x}$=3.40) and platemetal cold working occupation. These results indicate that the general sheet metal occupation and the auto body sheet metal occupation emphasize the skill of resistance welding more than the others do. It is understood that these two occupations relate to light gage sheet metal even though resistance welding is a specific type of welding procedure.

Regarding the skill of sheet metal pressworking, this information is included in Appendix C (Table 47).

There were significant differences between 1) welding working occupation ($\bar{x}$=1.85) and general sheet metal occupation ($\bar{x}$=2.96), and 2) welding working occupation and auto body sheet metal occupation ($\bar{x}$=2.96). As illustrated in Table 47, welding working occupation emphasize least these specific skills.

Regarding the skill of cold metal working, this information is included in Appendix C (Table 48).

There were significant differences between 1) general sheet metal occupation ($\bar{x}$=2.43) and platemetal cold working occupation ($\bar{x}$=3.67), and 2) sheet metal plastic forming occupation ($\bar{x}$=1.83) and platmetal cold working occupation. It is understood that skills in cold metal working are emphasized by the platemetal cold working occupation. On the other hand, the general sheet metal occupation and the sheet metal plastic forming occupation emphasize least the skills of platemetal cold working. This was not a surprising finding as platemetal cold working does require different equipment and processing from the two other occupations.

The results of analyses of variances relating to the breadth of skill among occupations are described in Table 30 (Appendix B).

Overall means and standard deviations shown in Table 5 indicate that respondents recognized that "arc welding" ($\bar{x}$=3.18) represented the most important skills. On the other hand, respondents mostly agreed that soldering and brazing were not necessary skills in their occupation.

Summary

Therefore, based on the results of analysis of data reported in Table 5, there was sufficient evidence to reject the null hypothesis. In summary, the breadth of skills are quite different among the occupations as indicated earlier. The overall means among these skills are also quite different. Aside from the needs of resistance welding skills and sheet metal pressworking skills, the sheet metal industry can be separated into two industries, namely, the light gage sheet metal and the heavy platemetal.

It should be noted that skills in soldering and brazing are not necessary in the sheet metal industry.

Null Hypothesis 2

It was hypothesized that no significant differences existed among subjects' perceptions of the knowledge requirements of sheet metal industry occupations. Findings regarding this hypothesis are presented in Table 6.

The analyses presented in Table 6 show that, except for knowledge of welding technology-- which received a relatively high rating mean ($\bar{x}$=3.28)-- all other variables received relatively low ratings. This indicates that high school students do not need to be taught such difficult knowledge to be able to perform sheet metal related jobs.

TABLE 6. Means, standard deviations and ANOVA relating to the knowledge requirements among the occupations

	Statement	Overall Means	Std. Dev.	F-Value
1.	Mechanical materials	2.62	1.03	1.89
2.	Welding technology	3.28	1.19	2.06
3.	Heat treatment	2.34	1.16	2.39
4.	Introduction of press working	2.69	1.15	3.06
5.	Piping and plumbing	2.19	1.35	1.95
6.	Sheet metal plastic forming	2.06	1.06	2.13
7.	Mechanics	2.36	1.18	0.74
8.	Material mechanics	2.45	1.16	0.69
9.	Numerical control skill	2.66	1.38	1.60
10.	Air-conditioning	2.28	1.26	1.92

The table also illustrates that the analysis of variance in F-values are not greater than the 0.05 level of significance. No significant difference in knowledge requirements was found among the included occupations. Therefore, Null Hypothesis 2 was accepted. The results of the analyses of variances regarding knowledge requirements among occupations are presented in Table 31 (Appendix B).

Summary

Perceptions of breadth of knowledge required were not different among the included sheet metal occupations. On the other hand, the extent of knowledge difficulty is quite different among occupations, as indicated in Table 6.

Knowledge of welding technology was reported as most necessary, and knowledge of sheet metal plastic forming as least necessary. The respondents indicated that most of the knowledge taught in schools is difficult to apply on the job.

Null Hypothesis 3

It was hypothesized that no significant differences exist in the perceptions among the respondents of different occupations regarding the skill difficulties. The findings with respect to this hypothesis are presented in Table 7 through Table 15.

The analyses presented in Table 7 show that skill in sheet metal bending received a relatively high rating ($\bar{x}$=3.53). On the other hand, skill in rivet working received a low rating. The table also shows that the analyses of variance of means for variables "sheet metal rolling," "sheet metal bending," and "sheet metal seam working" resulted in F-values being significant beyond the 0.01 level. The F-values for "rivet working" were significant beyond the 0.05 level. The analysis of variance related to the skill in general forming of light gage sheet metal is shown in the Table 32 (Appendix B).

TABLE 7. Means, standard deviations and ANOVA relating to the skills in general forming of light gage sheet metal

	Statement	Overall Means	Std. Dev.	F-Value
1.	Sheet metal rolling	2.87	1.51	8.92**
2.	Sheet metal bending	3.53	1.52	9.48**
3.	Sheet metal seam working	2.79	1.57	5.21**
4.	Rivet working	2.10	1.31	4.83*
5.	Complex objects layout and assimbling	2.63	1.51	3.09

*p<.05, **p<.01.

Scheffé's Multiple Range Test for all significant F-values revealed that the skills of general forming of light gage sheet metal differed significantly in terms of the ratings of all variables.

As shown in Table 49, Appendix C, ratings for teachers ($\bar{x}$=3.84) are higher than those for all other occupations, except for piping and plumbing occupation. The N value in piping and plumbing occupation was very small. Table 50,

Appendix C, also indicates that ratings of teachers ($\overline{x}$=4.12) and those of the general sheet metal occupation ($\overline{x}$=3.94) are significantly higher, in terms of the skill of sheet metal bending, than those of the platemetal cold working occupation ($\overline{x}$=2.83) and welding working occupation ($\overline{x}$=2.22). This indicates that sheet metal bending is one of the most important skills required for the general sheet metal occupation. Table 51, Appendix C, shows that the ratings of skills for teachers ($\overline{x}$=3.53) are significantly higher than are the ratings of skills in the general sheet metal occupation and platemetal cold working occupation. There is, however, no significant difference between every pair of occupations. Moreover, ratings for each occupation, taken separately, are relatively low (below 3). This indicates that skill in sheet metal seam working is relatively unimportant in the sheet metal related industry. There is a wide perception gap between teachers in schools and employees in industry.

Table 52, Appendix C, illustrates that ratings of the teachers ($\overline{x}$=2.73) are significantly higher than those of respondents from general sheet metal occupation, platemetal cold working occupation, and welding working occupation. In other words, there is no significant difference between every pair of occupations. The rating mean for each occupation is relatively very low (below 3). One conclusion that can be drawn from the results of analysis is that skill in rivet working is not necessary in sheet metal related industry.

The analysis presented in Table 8 indicates that skill in parallel line development received relatively high ratings ($\bar{x}$=3.45). The table also shows that the analysis of variance of means for all variables resulted in F-values significantly beyond the 0.01 level. The analysis of variance related to skills in the development method is presented in Table 33 (Appendix B).

TABLE 8. Means, standard deviations and ANOVA relating to the skills in development method

	Statement	Overall Means	Std. Dev.	F-Value
1.	Parallel line development	3.45	1.60	10.27^{**}
2.	Radial line development	2.97	1.57	9.46^{**}
3.	Triangulation development	2.89	1.60	5.30^{**}

$^{**}p<.01$.

Scheffé's Multiple Range Tests for all significant F-values revealed that skills in the development method differed significantly in the ratings of all variables. As shown in Table 53, Appendix C, the ratings of teachers differed ($\bar{x}$=4.38) significantly from all other respondents. The mean for every occupation was relatively high (> 3). This result indicates that the skill of parallel line development is necessary for all occupations. But, obviously, teachers' expectations for this skill are perceived to be higher.

Table 54, Appendix C, indicates that ratings of teachers ($\bar{x}$=3.96) are significantly higher than those of the general sheet metal occupation ($\bar{x}$=2.59), sheet metal plastic forming occupation ($\bar{x}$=2.17), platemetal cold working occupation ($\bar{x}$=2.76), and welding working occupation ($\bar{x}$=2.00). There is no significant difference in radial line development among the occupations, except for teachers.

Table 55, Appendix C, reveals results similar to those of Table 54. Ratings of teachers are relatively higher than those of other occupations, however, there is no significant difference in triangulation development skill among sheet metal related occupations.

It should be noted that, the teacher expectations about skill difficulty in development method are much higher than those of the workers in other occupations. Another finding is that skill difficulty for sheet metal related industry in parallel line development is higher than that for other skills in the same field.

The analyses presented in Table 9 show means, standard deviations, and analyses of variance related to the skill of auto body working. As shown in Table 9, the analysis of variance of means for all variables resulted in F-values significantly beyond the 0.01 level. The analysis of variance relating to the skill of auto body working is shown in the Table 34 (Appendix B).

TABLE 9. Means, standard deviations and ANOVA relating to the skills in auto body working

	Statement	Overall Means	Std. Dev.	F-Value
1.	Basic sheet metal stretching and compression wrinkling	2.82	1.59	27.68**
2.	Advanced sheet metal stretching and compression wrinkling	2.32	1.39	10.37**
3.	Panel replacement	2.70	1.70	22.31**
4.	Corrosion protection and painting	2.81	1.70	20.02**

**$p<.01$.

Scheffé's Multiple Range Tests for all significant F-values was employed. Table 56, Appendix C, shows that ratings, in terms of skill in basic sheet metal stretching and compression wrinkling, for teachers ($\bar{x}$=4.12) and for the auto body sheet metal occupation ($\bar{x}$=3.83) are significantly higher than those for the other occupations. An analysis of the details shows that the means of general sheet metal occupations, sheet metal plastic forming occupation ($\bar{x}$=1.92), platemetal cold working occupation ($\bar{x}$=1.97), and welding working occupation ($\bar{x}$=2.00) are relatively low. This indicates, in contrast, that this is a very important skill in auto body sheet metal occupation, and that it is not necessary for other occupations. The evidence indicates that what the teachers expect for this specific skill is to meet the needs of auto body sheet metal occupation. It is apparent that some skills have only specific or unique applications to a particular occuaption.

Characteristics of the results are the same in Table 57, Appendix C, as Table 56. The only difference between these tables is that Table 57 reveals much lower ratings for the welding working occupation ($\bar{x}$=1.74). This indicates that it is not necessary to require the difficult skill of sheet metal stretching and compression wrinkling to perform welding jobs.

Table 58, Appendix C, indicates that ratings for teachers ($\bar{x}$=3.78) and of the auto body sheet metal occupation ($\bar{x}$=4.06) are significantly higher than those for other occupations. It also indicates that the means of other occupations are relatively low. Ratings of the auto body sheet metal occupation are the highest, which indicats that the skill of panel replacement is very important to this group of workers.

Table 59, Appendix C, concerns the same characteristics as Table 58 does. Evidently, only the auto body sheet metal occupation emphasizes the skills of corrosion protection and painting. The ratings of these skills by other occupations are very low.

Table 10 illustrates the means, standard deviations and analyses of variance related to skills in gas welding and cutting. According to the analysis of variance of means for the skill of thin plate butt welding ($\bar{x}$=3.22), thin plate lap welding ($\bar{x}$=2.70), and gas cutting ($\bar{x}$=3.87) F-values were formed significantly beyond the 0.01 level. The analysis of variance relating to the skill of gas welding and cutting is presented in Table 35 (Appendix B).

Scheffé's Multiple Range Tests for all significant F-values are discussed. Regarding the skill of thin plate (< 2 mm) butt gas welding, Table 60, Appendix C, indicates that ratings for teachers ($\bar{x}$=4.28) are significantly higher than for general sheet metal occupation ($\bar{x}$=3.02), sheet metal

TABLE 10. Means, standard deviations and ANOVA relating to the skills in gas welding and cutting

	Statement	Overall Means	Std. Dev.	F-Value
1.	Thin plate (< 2 mm) butt welding	3.22	1.60	13.19**
2.	Thin plate lap welding	2.70	1.46	5.83**
3.	Thick plate (above 2 mm) flat welding	2.86	1.57	1.37
4.	Thick plate vertical welding	2.53	1.50	0.90
5.	Thick plate horizontal welding	2.59	1.56	0.98
6.	Gas cutting	3.87	1.40	3.34**

**$p<.01$.

plastic forming occupation ($\bar{x}$=2.17), platemetal cold working occupation ($\bar{x}$=1.90), and welding working occupation ($\bar{x}$=2.59). Occupation in platemetal cold working is also significantly lower than are the general sheet metal occupation ($\bar{x}$=3.02) and auto body sheet metal occupation ($\bar{x}$=3.49) are. It follows, therefore, that occupations in general sheet metal working and auto body sheet metal working emphasize this skill most.

Regarding the skill of thin plate lap gas welding, as shown in Table 61, Appendix C, ratings for teachers ($\bar{x}$=3.35) are significantly higher than those for the general sheet metal working ($\bar{x}$=2.24), and platemetal cold working ($\bar{x}$=1.83) occupations. There are no significant differences among the sheet metal related occupations. On the other hand, the means of occupations are lower than three; which shows that thin plate lap gas welding is emphasized most among the sheet metal related occupations.

Regarding the skill of gas cutting, Table 62, Appendix C, shows that ratings for teachers ($\bar{x}$=4.32) are significantly higher than those reported for the sheet metal plastic forming ($\bar{x}$=2.66) occupation. Moreover, most of the sheet metal related occupations had means higher than three, which indicates that all occupations emphasize this specific skill.

Table 11 presents means, standard deviations, and analyses of variance related to the skill of arc welding. Evidently, the analysis of variance of means for skills in flat position welding ($\bar{x}$=4.19), horizontal position welding ($\bar{x}$=3.54), vertical position welding ($\bar{x}$=3.39), corner joint welding ($\bar{x}$=3.62), pipe welding ($\bar{x}$=3.08), gas tungsten arc welding ($\bar{x}$=3.40), and submerged arc welding ($\bar{x}$=2.36) resulted in F-values significantly beyond the 0.01 level. The analysis of variance related to the skill of arc welding is shown in Table 36 (Appendix B).

TABLE 11. Means, standard deviations and ANOVA relating to the skills in arc welding

	Statement	Overall Means	Std. Dev.	F-Value
1.	Flat position	4.19	1.25	7.70**
2.	Horizontal position	3.54	1.37	3.16*
3.	Vertical position	3.39	1.45	4.17**
4.	Overhead position	2.73	1.41	0.96
5.	Corner joints	3.62	1.44	5.85**
6.	Pipe welding	3.08	1.49	6.73**
7.	Gas tungsten arc welding	3.40	1.57	5.19**
8.	Gas metal arc welding	3.72	1.47	3.92
9.	Submerged arc welding	2.63	1.52	3.49**

*$p<.05$, **$p<.01$.

Scheffé's Multiple Range Tests for all significant F-values are discussed. Regarding the skill of flat position arc welding, Table 63, Appendix C, illustrates that the ratings for the sheet metal plastic forming occupation ($\bar{x}$=2.42) are significantly lower than the ratings of the teachers ($\bar{x}$=4.57), general sheet metal ($\bar{x}$=4.26), platemetal cold working ($\bar{x}$=4.07), and welding working ($\bar{x}$=4.60) occupations. On the other hand, ratings for all occupations are relatively high. It can be inferred that with the exception of the sheet metal plastic forming occupation, all respondents of sheet metal related occupations recognize that flat position arc welding is a very important skill. Obviously, skill difficulty should be emphasized. Regarding the skill of horizontal position arc welding, Table 64, Appendix C, shows that the ratings of the sheet metal plastic forming occupation ($\overline{x}$=2.25) are significantly lower than those of the teachers ($\overline{x}$=3.88). Moreover, there is no significant differences among the sheet metal related occupations. The means of all occupations show that relatively high skill difficulty is required to perform these jobs.

Regarding the skill of vertical position arc welding, Table 65, Appendix C, shows that the ratings of the sheet metal plastic forming occupation ($\overline{x}$=2.00) are significantly lower than the ratings of the teachers ($\overline{x}$=3.73) and welding ($\overline{x}$=3.89) occupation. This fact indicates that the sheet metal plastic forming occupation does not emphasize vertical position arc welding as high as the other occupations do. The ratings of most occupations are more than three. Evidently, high skill difficulty is required to perform these jobs, except for that of sheet metal plastic forming occupation.

Regarding the skill of corner joint arc welding, Table 66, Appendix C, shows that the ratings of the sheet metal plastic forming occupation ($\bar{x}$=2.25) are significantly lower than the ratings of the teachers ($\bar{x}$=4.10) and welding working ($\bar{x}$=4.19) occupation. This follows that it is not necessary to emphasize this specific welding skill for the sheet metal plastic forming occupation. On the other hand, all of the ratings of the welding working occupation are relatively high; and it can be concluded that skill difficulty should be emphasized.

Regarding the skill of gas tungsten arc welding, Table 67, Appendix C, shows that the ratings for teachers ($\bar{x}$=4.22) are significantly higher than those for the general sheet metal working ($\bar{x}$=3.11) and auto body sheet metal working ($\bar{x}$=2.89) occupations. As shown in the table, the means of sheet metal related occupations are not as high as those expected by teachers. It should be noted that there is no significant difference found regarding skill of gas tungsten arc welding among the sheet metal related occupations.

Regarding the skill of pipe welding, Table 68, Appendix C, illustrates that the ratings for the general sheet metal occupation ($\bar{x}$=2.59) are significantly lower than those of teachers ($\bar{x}$=3.46) and welding working occupation ($\bar{x}$=4.00). The mean of the welding working occupation is significantly higher than that of the sheet metal plastic forming occupation. The table also indicates that the mean of the welding working occupation is the highest among all occupations. This means that the welding occupation emphasizes strongly the pipe welding skills.

Regarding the skill of submerged arc welding, Table 69, Appendix C, illustrates that the ratings of the teachers ($\bar{x}$=2.93) are significantly higher than those of the general sheet metal occupation ($\bar{x}$=1.92) and that there are no significant differences in terms of the skill of submerged arc welding among the sheet metal related occupations. The table also indicates that the mean of the platemetal cold working occupation is the highest ($\bar{x}$=3.62) among all occupations. This reveals that this skill difficulty should be emphasized more than that by other occupations. As shown in Table 11, flat position arc welding received the highest mean ($\bar{x}$=4.19) and submerged arc welding the lowest ($\bar{x}$=2.63). In summary, flat position arc welding is a very important, as well as, a difficult skill required in sheet metal related occupations.

Table 12 presents means, standard deviations, and analysis of variance related to the skills relevant to sheet metal pressworking. The analysis of variance of means for skills in "bending" ($\bar{x}$=3.14), and "drawing" ($\bar{x}$=3.05) resulted in F-values significantly beyond the 0.01 level. The analysis of variance related to the skills of sheet metal pressworking is presented in Table 37 (Appendix B).

TABLE 12. Means, standard deviations and ANOVA relating to the skills in sheet metal pressworking

	Statement	Overall Means	Std. Dev.	F-Value
1.	Bending	3.41	1.57	11.75**
2.	Drawing	3.05	1.54	6.71**
3.	Spinning	2.24	1.42	3.56

**p<.01.

Scheffé's Multiple Range Tests for all significant F-value variables were conducted. Regarding the skill of bending of pressworking, as shown in Table 70, Appendix C, the ratings of the teachers ($\bar{x}$=4.19) are significantly higher than ratings of sheet metal related occupations. Also, ratings of the general sheet metal occupation ($\bar{x}$=3.77) are significantly higher than those of the platemetal cold working ($\bar{x}$=2.65) and welding working ($\bar{x}$=2.00) occupations. Apparently, skill difficulty in the general sheet metal occupation should be emphasized more than those in the plate metal cold working and welding working occupations.

Regarding the skill of drawing of pressworking, Table 71, Appendix C, illustrates that ratings of the platemetal cold working occupation ($\bar{x}$=2.21) are significantly lower than those of the teachers ($\bar{x}$=3.36), and of the general sheet metal occupation ($\bar{x}$=3.17). Also, the ratings of the welding working occupation are significantly lower than those of the teachers, and the auto body sheet metal occupation ($\bar{x}$=3.26). It is apparent that the platemetal cold working and welding working occupations, which deal with heavy plate working, do not emphasize this specific skill. In other words, emphases on this skill can be reduced for these two occupational groups.

Table 13 presents means, standard deviations, and the analysis of variance related to the skills relevant to cold metal working. The analysis of variance of means for all skills resulted in F-values significant beyond the 0.01 level. The analysis of variance related to skills in cold metal working is presented in Table 38 (Appendix B).

Scheffé's Multiple Range Tests for all significant F-values are conducted. Regarding the skill of heavy gage metal layout and cutting, as shown in Table 72, Appendix C, both the ratings of the teachers ($\bar{x}$=3.84) and of the platemetal cold working occupation ($\bar{x}$=3.97) are significantly higher than the ratings of the general sheet metal working ($\bar{x}$=2.70) and sheet metal plastic forming ($\bar{x}$=2.00) occupations. This fact indicates that heavy gage metal layout and cutting is an important skill for the platemetal cold working occupation and that this skill is

TABLE 13. Means, standard deviations and ANOVA relating to the skills in cold metal working

	Statement	Overall Means	Std. Dev.	F-Value
1.	Heavy gage metal layout and cutting	3.20	1.50	7.52^{**}
2.	Heavy gage metal forming	3.07	1.50	8.67^{**}
3.	Construction working	2.83	1.47	5.03^{**}
4.	Heavy gage metal complex layout and forming	2.48	1.43	4.39^{**}

$^{**}p<.01$.

not so necessary for the general sheet metal and sheet metal plastic forming occupations.

Regarding the skill of heavy gage metal forming, Table 73, Appendix C, reveals the same characteristics as Table 72 since these two skills are part of the cold working procedure.

Regarding the skill of construction working, Table 74, Appendix C, indicates that the ratings of the teachers ($\bar{x}$=3.26) are significantly higher than those of both the general sheet metal working ($\bar{x}$=2.40) and sheet metal plastic forming ($\bar{x}$=1.58) occupations. Also, there are significant differences between the sheet metal plastic forming and platemetal cold working ($\bar{x}$=3.41) occupations. The platemetal cold working occupation group revealed the highest mean for construction working.

Regarding the skill of heavy gage metal complex layout and forming, Table 75, Appendix C, shows that the ratings of the platemetal cold working occupation are significantly higher than those of the general sheet metal occupation.

It was noted that the platemetal cold working occupation received the highest ratings among all occupations, for all four levels of skills. This means that skill difficulty can be emphasized for each of the cold metalworking skills in the platemetal cold working occupation.

Table 14 presents means, standard deviations, and the analysis of variance related to the skills of welding inspection. The table shows that the analysis of variance of means for all skills resulted in F-values significantly beyond the 0.01 level. The analysis of variance related to the skills in welding inspection is presented in Table 39 (Appendix B).

Scheffé's Multiple Range Tests for all significant F-values are discussed. As shown in Tables 76 through 78, Appendix C, they all present the same characteristics. The ratings of the teachers are significantly higher than either the ratings of the general sheet metal working or the sheet

TABLE 14. Means, standard deviations and ANOVA relating to the skills in welding inspection

	Statement	Overall Means	Std. Dev.	F-Value
1.	Destructive inspection	2.41	1.51	6.27**
2.	X-ray inspection	2.22	1.54	8.45**
3.	Ultrasonic inspection	2.29	1.54	9.58**
4.	Other pipe inspection	2.28	1.45	5.42**

**p<.01.

metal plastic forming occupations. On the other hand, these three skills, namely skills of destructive welding inspection, welding X-ray inspection, and welding ultrasonic wave inspection, received relatively low ratings for all of the sheet metal related occupations. It should be noted that there are no significant differences among sheet metal related occupations, which means that welding inspection is not an important skill in terms of performing these jobs.

Regarding the skill of other pipe inspections, Table 79, Appendix C, indicates that the ratings of the general sheet metal working occupation ($\bar{x}$=1.73) are significantly lower than both the ratings of the teachers ($\bar{x}$=2.86) and of the platemetal cold working occupation ($\bar{x}$=2.79). All the occupations also revealed relatively low ratings.

Table 15 presents means, standard deviations, and the analysis of variance relating to skills in numerical control working. The table illustrates that the analysis of variance of means for all skills resulted in F-values significantly beyond the 0.01 level. The analysis of variance related to skill in numerical control working is shown in Table 40 (Appendix B).

TABLE 15. Means, standard deviations and ANOVA relating to the skills in numerical control

	Statement	Overall Means	Std. Dev.	F-Value
1.	Software working	2.62	1.60	5.96**
2.	Setup and operation	2.78	1.64	4.71**

**p<.01.

Scheffé's Multiple Range Tests for all significant F-values are discussed. Regarding the skill of software working of numerical control machines, as shown in Table 80, Appendix C, the ratings of the teachers ($\bar{x}$=3.39) are significantly higher than the ratings of general sheet metal working ($\bar{x}$=2.49), platemetal cold working ($\bar{x}$=1.72), and welding working ($\bar{x}$=1.93) occupations. Regarding the skill of setup and operation of numerical control machines, Table 81, Appendix C, reveals that the ratings of the teachers

($\bar{x}$=3.46) are significantly higher than those of the platemetal cold working ($\bar{x}$=1.86) and welding working ($\bar{x}$=2.19) occupations. No significant differences among sheet metal related occupations exsit. On the other hand, all of the sheet metal related occupations received relatively low ratings (below three). This can be explained that neither the skills in software working, nor the skills in the setup and operation of numerical control machines are important for these occupations. Obviously, emphasis on skill difficulty can be reduced for all occupational groups.

<u>Summary</u>

The overall means of all item responses regarding the skill needed to perform the job show that the following items consistently received high scores (above three) from the respondents:

1. Sheet metal bending.
2. Parallel line development.
3. Thin plate butt gas welding.
4. Gas cutting.
5. Flat position arc welding.
6. Horizontal position arc welding.
7. Vertical position arc welding.
8. Corner joint arc welding.
9. Pipe arc welding.

10. Gas tungsten arc welding.
11. Gas metal arc welding.
12. Bending in press working.
13. Drawing in press working.
14. Heavy gage metal layout and cutting in cold metal working.
15. Heavy gage metal forming in cold metal working.

This research evidence shows that the above 15 items should be emphasized because of their skill difficulties.

On the other hand, the following items consistently received low scores (below 2.5) from respondents:

1. Rivet working.
2. Advanced sheet metal stretching and compression wrinkling.
3. Submerged arc welding.
4. Soldering and brazing.
5. Spinning in press working.
6. Heavy-guage metal complex layout and forming.
7. Welding destructive inspection.
8. Welding X-ray inspection.
9. Welding ultrasonic wave inspection.
10. Other pipe inspection.

This evidence shows that the above 10 items can be deemphasized because of their level of skill difficulties.

It is also evident that the ratings of the teachers are higher than those of other occupations. Although all occupations emphasized the various kinds of arc welding skills, general sheet metal and auto body sheet metal skills received higher scores than did the other occupations regarding gas tungsten arc welding. Also, these two occupations emphasized the skill of gas welding more. It can be concluded that general sheet metal and auto body sheet metal occupations have consistency in many skills, and platemetal cold working and welding working occupations have consistency in other skills.

Null Hypothesis 4

It is hypothesized that no significant differences exist regarding skill difficulties among teachers, supervisors, and skilled workers. Table 16 shows the results of means, standard deviations, and the analysis of variance related to skill difficulties among skilled workers, supervisors, and teachers. The analysis of variance related to the skill difficulties among skilled workers, supervisors, and teachers is shown in Table 41 (Appendix B). As shown in the table, all skills resulted in F-values significantly beyond the 0.01 level.

Based on the results of analysis reported in Table 16, there is sufficient evidence to reject the null hypothesis.

TABLE 16. Means, standard deviations and ANOVA relating to the skill difficulties among skilled workers, supervisors, and teachers

	Statement	Overall Means	Std. Dev.	F-Value
1.	General forming (light gage sheet metal)	2.55	1.00	21.91**
2.	Development method	2.78	1.39	26.45**
3.	Auto body working	2.87	1.35	33.36**
4.	Gas welding and cutting	2.80	1.10	8.06**
5.	Arc welding	3.18	1.05	10.03**
6.	Soldering and brazing	1.90	1.09	39.53**
7.	Resistance welding	3.02	1.63	21.83**
8.	Sheet metal pressworking	2.68	1.22	14.53**
9.	Basic bench working	2.64	1.35	39.93**
10.	Cold metal working	2.71	1.32	8.86**
11.	Plumbing and piping	2.02	1.22	11.30**
12.	Welding inspection	2.03	1.30	16.02**
13.	Numerical control	2.44	1.48	12.89**

**$p<.01$.

Scheffé's Multiple Range Tests for all significant F-values are recorded in Tables 82 through 94, Appendix C. There are some common characteristics shown in Tables 82 to 94. All tables show that the ratings of the teachers are significantly higher than the ratings of skilled workers and supervisors. These results suggest that skill expectations among teachers are higher than those among skilled workers and supervisors. Tables 83 and 90, Appendix C, also illustrate that the ratings of supervisors are significantly higher than those of skilled workers.

Summary

At least two reasons can be suggested for the high ratings of teachers: 1. The curriculum may be too difficult. 2. The teacher may not recognize what the industry needs. Other possibilities may be drawn that since teachers have to teach all phase of sheet metal, they must retain great depth of skill proficiency to execute their demonstrations to their students. Evidence also suggests that the skills emphasizing design, such as the development method received higher scores from supervisors.

Null Hypothesis 5

It is hypothesized that there are no significant differences between the sheet metal industry and the industrial/vocational senior high school curriculum in terms of skill breadth expectations. The findings regarding this hypothesis are presented in Tables 17 through 22.

Table 17 presents the skill ratings received from respondents of the general sheet metal working occupation, comparing what is needed by industry and taught in schools.

Evidently, the skill needed in arc welding, resistance welding, sheet metal pressworking, cold metal working, plumbing and piping, and numerical control working is significantly greater than that implied by school curricula. Results of the T-values are beyond the 0.01 level which indicates that the skills were not sufficiently emphasized in schools. However, the skill needed in development method and soldering and brazing is significantly lower than that implied by school curricula. This fact indicates that schools are probably either providing too extensive curricula to students, or are not providing employable skills to students.

Table 18 shows the skill rating received from respondents of the auto body sheet metal working occupation, comparing what is needed by industry and taught in schools. Results reveal that the skills of the general forming and of the development method are not in great demand by industry. The skills of auto body working, sheet metal pressworking, plumbing and piping, and numerical control working, however, are not emphasized enough by schools. Moreover, that T-values of the difference between industry and school ratings

TABLE 17. Skill differences between needed in industry and taught in schools (Occupation: General sheet metal working)

skills	Needed M(SD)	Taught M(SD)	Diff. M(SD)	T-Value
Skill 1	2.81(1.00)	3.06(0.99)	-.25(1.12)	-2.10
Skill 2	2.92(1.37)	3.74(1.17)	-0.81(1.58)	-0.84**
Skill 3	1.91(1.08)	2.01(0.96)	-.94(1.12)	-0.78
Skill 4	2.87(1.11)	2.55(1.05)	0.32(1.44)	2.06
Skill 5	3.21(1.01)	2.14(0.91)	1.07(1.30)	7.70**
Skill 6	1.83(1.15)	2.16(0.97)	-.33(1.22)	-2.53*
Skill 7	3.55(1.52)	2.68(1.31)	0.86(1.69)	4.79**
Skill 8	2.96(1.15)	1.95(0.96)	1.01(1.27)	7.43**
Skill 9	2.52(1.41)	2.82(1.37)	-.30(1.49)	-1.86
Skill 10	2.43(1.35)	1.81(0.96)	0.62(1.42)	4.12**
Skill 11	1.91(1.31)	1.47(0.89)	0.44(1.22)	3.41**
Skill 12	1.70(1.13)	1.58(0.90)	0.13(1.05)	1.11
Skill 13	2.64(1.53)	1.56(0.95)	1.08(1.71)	5.93**

*p<.05, **p<.01.

Skill1: General forming
Skill2: Development method
Skill3: Auto body working
Skill4: Gas welding
Skill5: Arc welding
Skill6: Soldering and brazing
Skill7: Resistance welding
Skill8: Pressworking
Skill9: Basic bench working
Skill10: Cold metal working
Skill11: Plumbing and piping
Skill12: Welding inspection
Skill13: Numerical control

of the skills of auto body working and sheet metal pressworking are beyond the 0.01 level which indicates that these two skills are emphasized by the auto body sheet metal working occupation.

TABLE 18. Skill differences between needed in industry and taught in schools (Occupation: Auto body sheet metal working)

skills	Needed M(SD)	Taught M(SD)	Diff. M(SD)	T-Value
Skill 1	2.65(0.94)	3.17(0.85)	-.51(1.22)	-2.50*
Skill 2	2.98(1.37)	3.87(0.89)	-0.89(1.71)	-3.06**
Skill 3	2.74(1.16)	2.36(0.88)	1.37(1.49)	5.45**
Skill 4	3.11(0.96)	2.92(0.90)	0.19(1.13)	0.99
Skill 5	2.98(1.16)	2.53(0.78)	0.44(1.55)	1.70
Skill 6	2.31(0.95)	2.25(0.98)	0.07(1.25)	0.31
Skill 7	3.40(1.59)	2.77(1.42)	0.63(1.73)	2.15
Skill 8	2.96(1.36)	2.05(1.04)	0.90(1.36)	3.92**
Skill 9	2.94(1.30)	3.14(1.31)	-.20(1.04)	-0.72
Skill 10	2.85(1.27)	2.35(0.92)	0.50(1.57)	1.88
Skill 11	2.40(1.23)	1.76(0.96)	0.64(1.32)	2.87*
Skill 12	2.31(1.34)	1.86(1.09)	0.44(1.15)	2.28
Skill 13	2.63(1.50)	1.89(1.21)	0.74(1.56)	2.82*

*$p<.05$, **$p<.01$.

Table 19 presents the skill ratings received from respondents of the sheet metal plastic forming occupation, comparing what is needed by industry and taught in schools. The table indicates that schools focus excessively on the skills of general forming, development method, and soldering and brazing. The T-values are significantly beyond the 0.05 level. The table also shows that most ratings of skills taught in schools are higher than those of skills needed by industry. It can be concluded that most of the skills listed in this study are excessively focused on by schools. In other words, other equally important skills are emphasized by the sheet metal plastic forming occupation. Perhaps it is not necessary to acquire skills at such levels of difficulty to perform these jobs.

Table 20 presents the skill ratings received from the respondents of the platemetal cold working occupation, comparing what is needed by industry and taught in schools.

The table shows that the ratings in terms of the importance in school curricula for the skills of general forming, development method, and soldering and brazing are significantly higher for the T-values beyond the 0.05 level. On the other hand, the need for welding inspection skills in industry is significantly higher than taught by school curricula, as evidenced by T-values beyond the 0.05 level.

TABLE 19. Skill differences between needed in industry and taught in schools (Occupation: Sheet metal plastic forming)

skills	Needed M(SD)	Taught M(SD)	Diff. M(SD)	T-Value
Skill 1	2.32(1.07)	3.32(0.91)	-1.0(1.19)	-2.92*
Skill 2	2.22(1.09)	3.25(1.13)	-1.03(1.30)	-2.74*
Skill 3	1.85(1.12)	2.04(0.89)	-.19(1.39)	-0.47
Skill 4	2.08(1.19)	2.85(1.19)	-.76(1.10)	-2.40
Skill 5	2.32(1.28)	2.44(0.93)	-.12(1.15)	-0.36
Skill 6	1.75(1.12)	2.44(1.26)	-.69(0.87)	-2.77*
Skill 7	2.50(1.78)	2.67(1.78)	-.17(1.59)	-0.36
Skill 8	2.61(1.13)	2.28(1.07)	0.33(1.29)	0.89
Skill 9	2.58(1.38)	2.42(1.16)	0.17(1.27)	0.46
Skill 10	1.83(0.85)	2.21(1.12)	-.83(1.22)	-1.07
Skill 11	1.75(1.08)	1.61(1.05)	0.14(1.27)	0.38
Skill 12	1.31(0.49)	1.56(0.91)	-.25(0.87)	-1.00
Skill 13	2.63(1.45)	2.04(1.21)	0.58(2.10)	0.96

*$p<.05$.

The table illustrates that skills in arc welding, cold metal working, and plumbing and piping are much more necessary in industry than is taught by school curricula. The T-values for such skills are significant beyond the 0.01 level. The platemetal cold working occupation is thus in great need of the skills related to arc welding and heavy plate working.

TABLE 20. Skill differences between needed in industry and taught in schools (Occupation: Platemetal cold working)

skills	Needed M(SD)	Taught M(SD)	Diff. M(SD)	T-Value
Skill 1	2.21(0.81)	2.84(1.08)	-.63(1.39)	-2.47*
Skill 2	2.89(1.49)	3.85(1.04)	-0.97(1.85)	-2.81*
Skill 3	1.92(1.27)	2.07(0.81)	-.15(1.04)	-0.76
Skill 4	2.45(1.02)	2.69(0.89)	-.24(1.55)	-0.84
Skill 5	3.35(1.07)	2.27(0.83)	1.08(1.32)	4.41**
Skill 6	1.76(1.00)	2.16(1.06)	-.40(0.88)	-2.45*
Skill 7	1.90(1.29)	2.17(1.00)	-.28(1.33)	-1.11
Skill 8	2.26(1.09)	2.28(1.04)	-.01(1.29)	-0.05
Skill 9	2.62(1.29)	2.83(1.28)	-.21(1.59)	-0.70
Skill 10	3.67(1.12)	2.34(1.29)	-1.34(1.64)	4.38**
Skill 11	2.01(1.04)	1.45(0.85)	-.56(0.93)	3.26**
Skill 12	2.56(1.58)	1.64(1.02)	0.92(1.66)	3.00*
Skill 13	1.79(1.22)	1.62(1.18)	0.17(1.16)	0.80

*p<.05, **p<.01.

Table 21 presents the skill ratings received from respondents of the welding working occupation, comparing what is needed by industry and taught in schools.

The table illustrates that the ratings of skills taught in schools, in terms of the skills of general forming and development method, are higher than those needed by industry. The T-values for these two skills are significantly beyond the 0.01 level. Again, the T-values for the skill of basic bench working taught in schools is significantly higher beyond the 0.05 level. However, ratings of skills needed by industry for the skills of arc welding, cold metal working, and plumbing and piping are higher than those taught in schools. T-values for those skills were significant beyond the 0.01 level.

This table also illustrates that, among all skills, the skill needed for arc welding is the highest and that the skill needed for soldering and brazing are the lowest.

Table 22 presents the skill ratings received from respondents of the piping or plumbing occupation, comparing what is needed by industry and taught in schools.

Because only three respondents participated in this study, the differences between skill ratings cannot yield statistically significant differences.

Summary

The analyses of the differences of means between skills needed by industry and taught in schools show that the scores related to the skills of general forming, development method, and soldering and brazing were consistently negative, which indicates that these three skills are overemphasized by schools. Platemetal cold working and

TABLE 21. Skill differences between needed in industry and taught in schools (Occupation: welding working)

skills	Needed M(SD)	Taught M(SD)	Diff. M(SD)	T-Value
Skill 1	2.02(1.04)	3.36(1.18)	-1.33(1.46)	-4.73**
Skill 2	2.07(1.30)	3.68(1.36)	-1.60(1.86)	-4.48**
Skill 3	2.04(1.29)	1.94(0.83)	0.10(1.68)	0.31
Skill 4	2.87(1.17)	2.76(0.96)	0.11(1.09)	0.53
Skill 5	3.58(0.63)	2.42(0.74)	1.17(0.77)	7.89**
Skill 6	1.72(1.05)	2.15(1.02)	-.43(1.33)	-1.69
Skill 7	2.15(1.32)	2.63(1.18)	0.48(1.28)	-1.95
Skill 8	1.85(1.00)	1.73(0.74)	0.12(1.09)	0.54
Skill 9	2.67(1.30)	3.04(1.09)	-.37(1.76)	-1.10*
Skill 10	2.77(1.21)	1.94(0.97)	0.82(1.26)	3.39**
Skill 11	1.85(0.84)	1.19(0.51)	0.67(0.78)	4.42**
Skill 12	2.40(1.35)	1.96(1.26)	0.44(2.09)	1.08
Skill 13	2.06(1.36)	1.83(1.20)	0.22(1.89)	0.61

*p<.05, **p<.01.

welding occupations are in great need of the skills of welding related working,-- namely, of arc welding and welding inspection, --and heavy plate related working, --namely of cold metalworking, plumbing and piping. Interestingly, gas welding skills were emphasized by the

TABLE 22. Skill differences between needed in industry and taught in schools (Occupation: Piping or plumbing)

skills	Needed M(SD)	Taught M(SD)	Diff. M(SD)	T-Value
Skill 1	2.87(0.76)	3.33(1.15)	-.47(0.42)	-1.94
Skill 2	3.89(1.17)	3.89(1.39)	0 (0.33)	0
Skill 3	3.75(0.66)	2.58(1.01)	1.67(1.18)	1.71
Skill 4	3.17(1.04)	2.50(0.50)	0.67(0.76)	1.51
Skill 5	2.63(1.05)	2.30(1.12)	0.33(1.76)	0.33
Skill 6	3.00(1.20)	2.89(1.35)	0.11(0.19)	1.00
Skill 7	4.00(1.00)	4.00(1.00)	0. (0)	.
Skill 8	3.00(1.20)	2.00(1.20)	1 (1.20)	1.44
Skill 9	2.67(1.53)	3.00(1.00)	-.33(0.58)	-1.00
Skill 10	2.83(0.76)	2.00(0.87)	0.83(1.53)	0.94
Skill 11	3.33(2.08)	2.78(1.58)	0.56(0.96)	1.00
Skill 12	2.92(0.76)	2.41(1.01)	0.50(1.15)	0.66
Skill 13	3.67(1.15)	2.50(1.32)	1.17(2.47)	0.82

general sheet metal and auto body sheet metal occupations. All ratings of skill needed by the sheet metal plastic forming occupation are much lower than of those which were taught in schools. It seems that a lower level of skill is needed for this specific occupation. Another probability is that different skills are required from those of the sheet metal related industry.

The data also show that soldering and brazing skills always received low scores, and that there was a significant difference between the skill needed by industry and that taught in schools. It can be concluded that this skill is not necessary in the sheet metal related industry in Taiwan.

<u>Null Hypothesis 6</u>

It was hypothesized that there were no significant differences in knowledge expectations between the sheet metal industry and the curricula in industrial/vocational senior high schools. The findings with respect to this hypothesis are presented in Tables 23 though 28.

The analyses presented in Table 23 are the differences, in terms of respondents in the general sheet metal working occupation, between knowledge currently needed in industry and knowledge taught in schools. The table illustrates that the ratings taught in schools for mechanics are higher than those that are needed by industry. The T-value for the rating difference is significant beyond the 0.01 level. On the other hand, the ratings which were taught in schools for "introduction of pressworking" and "numerical control" are lower than those needed by industry. The T-values for the rating differences are significant beyond the 0.01 level.

Again, the ratings for welding technology taught in schools are lower than those which needed by industry. The T-values for the rating differences are significant beyond the 0.05 level. These facts indicate that mechanics is not necessary to be emphasized by general sheet metal occupation. Knowledge of welding technology, numerical control, and theory of pressworking, however, should be emphasized in these curricula.

TABLE 23. Knowledge differences between needed in industry and taught in schools (Occupation: General sheet metal working)

skills	Needed M(SD)	Taught M(SD)	Diff. M(SD)	T-Value
Know. 1	2.50(0.99)	2.56(0.94)	-.05(1.24)	-0.40
Know. 2	3.22(1.22)	2.80(1.06)	0.43(1.35)	2.97*
Know. 3	2.11(1.09)	2.37(1.08)	-.26(1.31)	-1.84
Know. 4	2.91(1.17)	2.35(0.96)	0.55(1.45)	3.55**
Know. 5	1.94(1.33)	2.09(1.17)	-.15(1.55)	-0.93
Know. 6	2.01(1.07)	2.01(1.01)	0.00(1.12)	-0.02
Know. 7	2.29(1.27)	2.87(1.16)	-.58(1.55)	-3.49**
Know. 8	2.33(1.20)	2.60(1.15)	-.27(1.33)	-1.87
Know. 9	2.82(1.42)	1.97(1.16)	0.85(1.88)	4.22**
Know. 10	2.18(1.31)	2.31(1.09)	-.13(1.52)	-0.83

*$p<.05$, **$p<.01$.

The analyses presented in Table 24 are the differences in terms of respondents in the auto body sheet metal working occupation, between knowledge currently needed by industry and that taught in schools. The table illustrates that the ratings of knowledge for mechanics taught in schools are higher than those needed by industry for the T-value was significant beyond the 0.01 level. No significant differences for other variables are found in this table, which indicates that there is no need for schools to emphasize mechanics for the auto body sheet metal working occupation.

The analyses presented in Table 25 are the differences, in terms of respondents in the sheet metal plastic forming occupation, regarding knowledge currently needed by industry and that taught in schools. The table illustrates that there are no significant differences between those two variables. This fact indicates that the knowledge which was taught in schools is appropriate for industrys' needs.

Table 26 presents the differences, in terms of respondents in the platemetal cold working occupation, between the knowledge currently needed by industry and that taught in schools. The table illustrates that the ratings for the welding technology taught in schools are lower than those needed by industry for the T-value was significant beyond the 0.01 level. No significant differences among

TABLE 24. Knowledge differences between needed in industry and taught in schools (Occupation: Auto body sheet metal working)

skills	Needed M(SD)	Taught M(SD)	Diff. M(SD)	T-Value
Know. 1	2.93(1.00)	2.75(0.90)	0.18(1.22)	0.87
Know. 2	3.28(1.09)	3.22(0.94)	0.06(1.19)	0.28
Know. 3	2.54(1.11)	2.70(1.02)	-.16(1.53)	-0.63
Know. 4	2.84(1.12)	2.63(1.05)	0.21(1.49)	0.84
Know. 5	2.46(1.36)	2.04(1.06)	0.42(1.28)	1.94
Know. 6	2.35(1.09)	2.13(1.00)	0.22(1.23)	1.07
Know. 7	2.38(1.03)	3.14(0.85)	-.76(1.26)	-3.57**
Know. 8	2.58(1.04)	2.63(0.95)	-.05(1.43)	-0.22
Know. 9	2.58(1.21)	2.24(1.14)	0.34(1.42)	1.42
Know. 10	2.77(1.34)	2.69(0.90)	0.09(1.38)	0.37

**$p<.01$.

other variables was found in the table, which indicates that schools should emphasize knowledge of welding technology for the platemetal cold working occupation.

Regarding the knowledge differences, in terms of respondents of the welding and piping or plumbing occupations, Tables 27 and 28 exhibit similar characteristics. These tables illustrate no significant differences among variables. As mentioned earlier, however,

TABLE 25. Knowledge differences between needed in industry and taught in schools (Occupation: Sheet metal plastic forming)

skills	Needed M(SD)	Taught M(SD)	Diff. M(SD)	T-Value
Know. 1	2.82(1.09)	2.11(0.62)	0.71(1.26)	1.95
Know. 2	2.41(1.04)	2.66(0.80)	-.25(1.07)	-0.81
Know. 3	2.74(1.27)	2.52(1.04)	0.23(1.29)	0.60
Know. 4	2.59(1.12)	2.05(0.62)	0.54(1.04)	1.80
Know. 5	2.30(1.12)	1.92(0.91)	0.38(1.41)	0.93
Know. 6	2.12(1.16)	1.88(0.76)	0.24(1.32)	0.63
Know. 7	2.57(1.17)	3.02(0.70)	-.45(1.07)	-1.45
Know. 8	2.48(1.36)	2.73(0.83)	-.25(1.09)	-0.79
Know. 9	2.95(1.38)	2.09(1.16)	0.86(2.05)	1.45
Know. 10	2.15(0.98)	2.27(0.65)	-.11(1.23)	-0.30

only three respondents were in the piping or plumbing occupation. It is thus difficult to attain statistical significance. Table 27 presents that there are consistent ratings in term of the knowledge taught in schools and needed by industry.

TABLE 26. Knowledge differences needed in industry and taught in schools (Occupation: Platemetal cold working)

skills	Needed M(SD)	Taught M(SD)	Diff. M(SD)	T-Value
Know. 1	2.43(0.92)	2.37(0.95)	0.06(1.16)	0.27
Know. 2	3.55(1.13)	2.78(1.01)	0.77(1.31)	3.16**
Know. 3	2.34(1.17)	2.22(1.08)	0.12(1.51)	0.44
Know. 4	2.40(0.91)	2.14(0.80)	0.26(1.13)	1.32
Know. 5	2.59(1.37)	1.96(1.11)	0.62(1.75)	1.92
Know. 6	1.93(0.89)	1.95(0.98)	-.02(0.99)	-0.11
Know. 7	2.38(1.02)	2.21(0.92)	0.18(1.48)	0.65
Know. 8	2.51(1.09)	2.23(0.94)	0.29(1.46)	1.06
Know. 9	2.26(1.14)	1.89(1.02)	0.37(1.42)	1.39
Know. 10	2.09(1.02)	1.94(0.91)	0.16(0.98)	0.85

**$p<.01$.

Summary

The conclusion is drawn that perceptions of knowledge required by all sheet metal related occupations are consistent between industry and industrial/vocational senior high schools. In other words, the information covered by school curricula consistently prepares students for the actual requirements of sheet metal related occupations. Respondents from the general sheet metal working and the

TABLE 27. Knowledge differences between needed in industry and taught in schools (Occupation: Welding working)

skills	Needed M(SD)	Taught M(SD)	Diff. M(SD)	T-Value
Know. 1	2.60(1.19)	2.31(0.90)	0.29(1.42)	1.07
Know. 2	2.49(1.23)	2.94(1.03)	0.56(1.41)	2.04
Know. 3	2.48(1.30)	2.24(1.02)	0.24(1.49)	0.85
Know. 4	2.08(1.21)	2.14(0.83)	-.07(1.04)	-0.33
Know. 5	2.04(1.40)	1.67(0.72)	0.37(1.45)	1.33
Know. 6	1.79(1.00)	1.79(0.91)	0.01(0.91)	-0.04
Know. 7	2.29(1.26)	2.77(1.09)	-.48(1.51)	-1.66
Know. 8	2.49(1.18)	2.68(1.09)	-.20(1.42)	-0.72
Know. 9	2.38(1.60)	1.94(1.07)	-.44(2.11)	1.08
Know. 10	2.10(1.28)	2.36(1.22)	-.26(1.66)	-0.82

auto body sheet metal working occupations, however, believe that mechanics need not be emphasized as is currently the practice in schools. On the other hand, welding technology is emphasized by both the platemetal cold metal working and general sheet metal working occupations. It is believed that such a small knowledge difference among the needs of occupations does not present any problems for educators in terms of curriculum development.

TABLE 28. Knowledge differences between needed in industry and taught schools (Occupation: Piping or plumbing)

skills	Needed M(SD)	Taught M(SD)	Diff. M(SD)	T-Value
Know. 1	3.73(0.42)	3.83(0.49)	-.10(0.70)	-0.25
Know. 2	4.00(0.92)	3.50(0.40)	0.50(1.35)	0.64
Know. 3	3.87(0.32)	3.23(0.32)	0.63(0.32)	3.41
Know. 4	3.43(0.32)	3.13(0.04)	0.30(0.96)	0.54
Know. 5	3.33(1.18)	2.81(1.58)	0.52(0.57)	1.58
Know. 6	3.47(0.47)	3.17(0.76)	0.30(1.04)	0.50
Know. 7	3.53(0.15)	3.43(1.05)	0.10(0.90)	0.19
Know. 8	3.40(0.61)	2.63(1.18)	0.77(1.05)	1.26
Know. 9	3.90(0.52)	3.23(0.72)	0.67(1.24)	0.93
Know. 10	3.37(0.65)	3.07(1.38)	0.30(0.78)	0.67

Null Hypothesis 7

It is hypothesized that no significant opinion differences can be found among different kinds of skills needed in industry and taught in schools. Tables regarding this hypothesis are presented in Appendix D (Tables 105 through 110). Overall analyses for each occupation are emphasized in order to determine what the skill congruency pattern is currently.

Table 105 (Appendix D), presents correlation coefficients of the ratings of all pair skills for the general sheet metal working occupation. The table illustrates that the skills of general forming, development method, auto body working, soldering and brazing, basic bench working, cold metal working, plumbing and piping, and welding inspection have a consistent tendency and that they result in P-values significant beyond the 0.05 level. The overall means, however, of soldering and brazing ($\bar{x}$=1.83), plumbing and piping ($\bar{x}$=1.91), and welding inspection ($\bar{x}$=1.71) skills are consistently low. Other skills, namely general forming, development method, auto body working, and cold metal working, that received consistently high scores, are the dominant skills of the general sheet metal occupation.

Table 106 (Appendix D), presents the correlation coefficients of the ratings of all pair skills for the auto body sheet metal working occupation. The table illustrates that the skills of general forming, gas welding, arc welding, sheet metal pressworking, cold metal working, plumbing and piping, and welding inspection indicate a pattern of consistency and result in P-values significant beyond the 0.05 level. The overall means of plumbing and piping ($\bar{x}$=2.40) and welding inspection ($\bar{x}$=2.31) skills, however, are consistently low. Other skills, namely general forming, gas welding, arc welding, sheet metal pressworking, and cold working, that received consistently high scores are the dominant skill requirements of the auto body sheet metal working occupation.

Table 107 (Appendix D), presents the correlation coefficients of the ratings of all pair skills for the sheet metal plastic forming occupation. The table illustrates that the skills of general forming, auto body working, gas welding, cold metal working, plumbing and piping, and welding inspection have a consistent pattern, for the P-values were significant beyond the 0.05 level. The overall means, however, of the skills of auto body working ($\bar{x}$=1.85), cold metal working ($\bar{x}$=1.83), plumbing and piping ($\bar{x}$=1.75), and welding inspection ($\bar{x}$=1.31) are consistently low. Other skills, namely general forming, and gas welding, that received consistently high scores are the dominant skills pattern of the sheet metal plastic forming occupation.

Table 108 (Appendix D), presents the correlation coefficients of the ratings of all pair skills for the platemetal cold working occupation. Although significant differences occur between some of the paired skills, no pattern in correlation coefficients can be found.

Table 109 (Appendix D), presents the correlation coefficients of the ratings of all pair skills for the welding working occupation. The table illustrates that the skills of general forming, development method, arc welding, resistance welding, sheet metal pressworking, and cold metal working have a consistent pattern for the P-values were significant beyond the 0.05 level. The overall means, however, of the skills of general forming ($\overline{x}$=2.02), development method ($\overline{x}$=2.07), resistance welding ($\overline{x}$=2.15), and sheet metal pressworking ($\overline{x}$=1.85) are consistently low. Other skills, namely arc welding and cold metal working, received consistently high scores are the dominant skills pattern of the welding occupation.

Table 110 (Appendix D), presents the correlation coefficients of the ratings of all pair skills for the piping or plumbing occupation. Because of the limited number of repondents, no significant difference for any paired skills was found.

Summary

Therefore, based on the results of analysis of the data reported in the Appendix D, there was sufficient evidence to reject the Null Hypothesis. In short, as indicated earlier the Pearson correlation coefficients indicated that skill pattern requirements are quite different among occupations and not highly correlated.

The skills of general forming, development method, auto body working, and cold metal working are the dominant skill pattern of the general sheet metal working occupation. The skills of general forming, gas welding, arc welding, sheet metal pressworking, and cold metal working are the dominant skill pattern requirements of the auto body sheet metal working occupation. The skills of general forming and gas welding are the dominant skill pattern requirements of the sheet metal plastic forming occupation. The skills of arc welding and cold metal working are the dominant skill pattern requirements of the welding occupation. The dominant skills with skill pattern requirements in a particular occupation can be combined into skill clusters.

Null Hypothesis 8

It was hypothesized that no significant differences in opinions existed among skilled workers, supervisors, and teachers regarding the extent of knowledge necessary for an occupation. Table 29 illustrates the results of the means, standard deviations, and analyses of variance regarding the perceived knowledge requirements of skilled workers, supervisors, and teachers.

As shown in Table 29, there are significant differences in all levels of knowledge. Based on the results of analyses of data presented, there is sufficient evidence to reject the Null Hypothesis.

TABLE 29. Means, standard deviations and ANOVA relating to the knowledge requirements among skilled workers, supervisors, and teachers

	Statement	Overall Means	Std. Dev.	F-Value
1.	Mechanical materials	2.62	1.03	29.5**
2.	Welding technology	3.28	1.19	13.8**
3.	Heat treatment	2.34	1.16	31.9**
4.	Introduction of press working	2.69	1.15	24.9**
5.	Piping and plumbing	2.19	1.35	21.0**
6.	Sheet metal plastic forming	2.06	1.06	33.6**
7.	Mechanics	2.36	1.18	42.3**
8.	Material mechanics	2.45	1.16	25.6**
9.	Numerical control skill	2.66	1.38	22.9**
10.	Air-conditioning	2.28	1.26	18.9**

**$p<.01$.

Scheffé's Multiple Range Tests for all significant F-values are recorded in Tables 95 through 104 (Appendix C). There are some common characteristics shared in Table 95 to 104. All tables show that the ratings of the teachers are significantly higher than the ratings of skilled workers or the supervisors. These results suggest that knowledge perceptions among teachers are higher than those among skilled workers and supervisors. Tables 95, 98, and 103, which deal with the knowledge of mechanical materials, introduction of pressworking, and numerical control, also illustrate that the ratings of supervisors are significantly higher than those of skilled workers.

Summary

Therefore, based on the results of the analysis of data reported in Table 29, there was sufficient evidence to reject the null hypothesis. As mentioned earlier, several reasons can be found for the high ratings of teachers. Firstly, it is probable that teachers teach all phases of sheet metal related occupations, and as such they should have higher knowledge perceptions than supervisors and skilled workers do. The second probability is that the curriculum itself may be organized with too excessive difficultly.

Other evidence suggests that the knowledge emphasizing automatic manufacturing and use of appropriate materials, such as numerical control, pressworking, and mechanical materials, received higher ratings from supervisors.

CHAPTER V. CONCLUSIONS AND RECOMMENDATIONS

This study was designed to assess the curriculum within the sheet metal departments in Taiwan schools by gathering the perceptions of teachers in sheet-metal departments of industrial/vocational senior high schools and supervisors and skilled workers in sheet metal related industry.

In the following sections, the findings reported in Chapter IV are summarized so that conclusions can be drawn. Finally, several recommendations are made based upon the conclusions of the study.

Conclusions

The conclusions of this study are presented in two parts: (1) conclusions related to the research hypotheses, and (2) conclusions related to other aspects of the curriculum structure, and occupational classification of industrial/vocational education in Taiwan. Each hypothesis is restated and then followed by a conclusion based on the findings presented in Chapter IV. A brief discussion of each conclusion is included.

Null Hypothesis 1

It was hypothesized that no significant differences in the skill breadth were found among the occupations related to sheet metal industry in Taiwan.

<u>Conclusion 1</u>

Based on the findings reported in Table 5 of Chapter IV, there was sufficient evidence to reject the Null Hypothesis. The findings reported in Chapter IV indicate that the breadth of skills are quite different among sheet metal related occupations.

Regarding the skills needs for resistance welding, platemetal cold working, and sheet metal pressworking skills, the sheet metal industry can be separated into two industries: namely light gage and heavy platemetal. Resistance welding and sheet metal pressworking skills belong to the light gage industry, and platemetal cold working skill belongs to the heavy platemetal industry.

The ratings of the means for soldering and brazing skills are very low,as perceived by all occupations. Neither seem to be necessary skills in the sheet metal industry.

The skills of auto body working were emphasized only by the auto body sheet metal working occupation (Table 44), which implies that auto body working skills are unique expertise skills and not necessary for other occupations. It is, therefore, necessary to consider the appropriateness of auto body sheet metal working skills in the mechanical family of occupations.

Most occupations emphasize the skills of arc welding ($\bar{x}$=3.18), which implies that these particular skills are very important in sheet metal related industries (both light gage and heavy plate). So emphasis on arc welding skills in the Curriculum Standards is appropriate.

Null Hypothesis 2

It was hypothesized that no significant differences existed among subjects' perceptions of knowledge requirements of sheet metal industry occupation in Taiwan.

Conclusion 2

Based on the findings presented in Table 6 (Chapter IV), there were no significant differences among the respondents' perceptions of sheet metal industry occupations. This finding implies that the presented knowledge in this study was not perceived to be different by all sheet metal industry occupations. Therefore, the Null Hypothesis was not rejected. There were some notable mean differences among the items in Table 6, however. Knowledge of welding technology was reported as most necessary. Table 5 presents similar information regarding the skills of arc welding. It can be concluded that both skills and knowledge in the welding curriculum in high schools should be emphasized. According to the information presented in Table

5, it is also understood that the section of arc welding within welding technology should be emphasized most.

On the other hand, knowledge of sheet metal plastic forming and piping and plumbing received relatively low means. The conclusion can be drawn that the courses provided in schools may be too broad. This phenomenon should be considered in amending Curriculum Standards.

Null Hypothesis 3

It was hypothesized that no significant differences exist in the perceptions among the respondents of different occupations regarding the skill difficulties.

Conclusion 3

Based on the findings presented in Tables 7 through 15 (Chapter IV), there is sufficient evidence to reject the Null Hypothesis. These tables indicate that the general sheet metal working occupation emphasized the skills of sheet metal bending, parallel line development, thin plate butt welding, gas cutting, flat position arc welding, horizontal position arc welding, corner joints arc welding, pipe arc welding, gas tungsten arc welding, resistance welding, pressbending, and pressdrawing. Additionally, this specific occupation does not emphasize the skill of thick plate flat gas welding, thick plate horizontal gas welding, all forms of auto body working, all forms of soldering and brazing, and all forms of welding inspections.

The auto body sheet metal occupation emphasized the skills of sheet metal bending, parallel line development, basic sheet metal stretching and compression wrinkling, panel replacement, corrosion protection, painting, thin plate butt gas welding, gas cutting, flat position arc welding, horizontal position arc welding, vertical position arc welding, corner joints arc welding, pipe arc welding, gas tungsten arc welding, resistance welding, pressdrawing, and construction working. On the other hand, this specific occupation does not emphasize the skills of thick plate flat gas welding, thick plate horizontal gas welding, submerged arc welding, all kinds of soldering and brazing, spinning, all kinds of welding inspections.

The sheet metal plastic forming occupation emphasizes the skills of sheet metal bending, parallel line development, gas cutting, press bending, and pressdrawing. On the other hand, the skills of triangulation development, all kinds of auto body working, thin plate butt gas welding, thick plate flat gas welding, thick plate horizontal gas welding, horizontal position arc welding, vertical position arc welding, corner joints arc welding, pipe arc welding, submerged arc welding, all kinds of soldering and brazing, spinning, and all kinds of welding inspections are emphasized least.

The platemetal cold working occupation emphasizes the skills of sheet metal bending, parallel line development, gas cutting, flat position arc welding, horizontal position arc welding, vertical position arc welding, corner joints arc welding, pipe arc welding, submerged arc welding, heavy gage metal layout and cutting, heavy gage metal forming, construction working, and heavy guage metal complex layout and forming. On the other hand, this specific occupation does not emphasize the skills of basic sheet metal stretching and compression wrinkling, panel replacement, corrosion protection and painting, thin plate butt gas welding, thick plate gas welding, thick plate gas welding, all kinds of pressworking.

The welding working occupation emphasize the skills of gas cutting, flat position arc welding, horizontal position arc welding, corner joints arc welding, pipe arc welding, gas tungsten arc welding, gas metal arc welding, and heavy gage metal layout and cutting.

It is evident that some skills dealing with light gage sheet metal working-- such as sheet metal bending, thin plate butt welding, resistance welding, pressbending, and pressdrawing-- are emphasized by the general sheet metal working and the auto body sheet metal working occupations. Moreover, the skills dealing with heavy plate working,-- such as gas cutting, arc welding, submerged arc welding, heavy gage metal layout and cutting, heavy gage metal forming, piping and plumbing, and welding inspection are emphasized by the platemetal cold working and the welding working occupations.

There are common skills emphasized by both the light gage sheet metal working and heavy plate working, such as the skills of gas cutting, flat position arc welding, gas tungsten arc welding, and construction working.

On the other hand, some skills have only specific applications to particular occupations. Examples of this phenomenon are sheet-metal stretching and compression wrinkling, panel replacement, corrosion protection and painting within the auto body sheet metal occupation; and heavy gage metal forming to the platemetal cold working occupation.

Another conclusion that can be drawn is that few skills are emphasized by the sheet metal plastic forming occupation. Moreover, those skills emphasized are the same as those emphasized by the general sheet metal working occupation, but the former did not receive ratings as high as those of the general sheet metal working occupation.

This fact indicates that the plastic sheet metal occupation seems to be a semi-skilled working occupation.

The skills of numerical control working are not emphasized by all occupations, but the ratings of teachers are significantly higher than those of the other respondents. It is likely that teachers foresee automation to be a future trend.

Null Hypothesis 4

It was hypothesized that no significant differences exist regarding skill difficulties among teachers, supervisors, and skilled workers.

Conclusion 4

Based on the results of the analysis reported in Table 16 (Chapter IV), there is sufficient evidence to reject the Null Hypothesis. Scheffé's Tests for all significant F-values in Tables 82 through 94 indicate that the ratings of the teachers are significantly higher than those of skilled workers and supervisors. Teachers may teach all phases of sheet metal skills, and they may retain greater depth of skill proficiency to execute their demonstrations to their students. Two other reasons may explicate why teachers teach too broadly and too deeply: The curriculum may be too difficult, and teachers may not recognize precisely what the industry needs. The evidence presented at the conclusion of hypothesis 3 states that the needs of every occupation are different. How many sheet metal related occupations are involved in the sheet metal curriculum? In other words, how many skills are involved in the sheet metal curriculum? Do we need to separate the sheet metal related occupations into two groups: namely light gage sheet metal working and heavy plate working industries, or more groups? The answers to these questions will influence the career choices of school graduates, as well as the manpower market. The evidence presented in Table 16, regarding the ratings by teachers of soldering and brazing skills are significantly higher than those by skilled workers and supervisors with F-values beyond the 0.01 level. But earlier findings indicate that these particular skills are not emphasized by all sheet metal related occupations. Thus, developing a curriculum to meet the needs of sheet metal industry is an important priority.

Null Hypothesis 5

It was hypothesized that there are no significant differences in terms of skill breadth expectations between the sheet metal industry and the industrial/vocational senior high school curriculum.

Conclusion 5

Based on the results of analysis reported in Tables 17 through 22, there is sufficient evidence to reject the Null Hypothesis. The conclusions can be drawn according to differences among occupations.

Skills of general forming, development method, and soldering and brazing are overemphasized in the school curriculum. Similar findings in the Null Hypothesis 3 indicated that radial line development and triangulation development can be revised to simplify the content in the school curriculum. According to the results regarding Null Hypothesis 1, the skills of soldering and brazing were not perceived as necessary in all sheet metal related occupations, and could be, therefore, canceled in the Curriculum Standards. Regarding the general sheet metal working occupation, however, the skills of arc welding, resistance welding, sheet metal pressworking, cold metal working, plumbing and piping, and numerical control working should be emphasized in the school curriculum.

Regarding the auto body sheet metal working occupation, the skills of auto body working, sheet metal pressworking, plumbing and piping, and numerical control working should be emphasized in Curriculum Standards.

Regarding the platemetal cold working occupation, the skills of arc welding, cold metal working, plumbing and piping, and welding inspection should be emphasized in Curriculum Standards.

Regarding the welding working occupation, the skills of arc welding, cold metal working and, plumbing and piping should be emphasized in Curriculum Standards.

There is no specific skill to be emphasized for the sheet-metal plastic forming and piping or plumbing occupations. The limitation of a small sample in plumbing and piping may have contributed to inadequate data for meaningful analysis.

If the sheet metal related industry were separated into the heavy plate and the light gage sheet metal industries, the skills of arc welding and plumbing and piping, as heavy plate industry, would be emphasized in the current Curriculum Standards. The skills of sheet metal pressworking and numerical control would be emphasized within the light gage sheet metal industry.

The skill of arc welding is emphasized most among all skills for the sheet metal related industry.

Null Hypothesis 6

It was hypothesized that there were no significant differences in knowledge expectations between the sheet metal industry and the curricula in industrial/vocational senior high schools in Taiwan.

Conclusion 6

Based on the results of the analyses reported in Tables 23 through 28, perceptions of the knowledge required by all sheet metal related occupations are generally consistent between industry and schools. However, there is sufficient evidince to reject the Null Hypothesis. Respondents from the general sheet metal working and the auto body sheet metal working occupations believe that mechanics need not be emphasized. On the other hand, welding technology is emphasized by both the platemetal cold metal working and general sheet metal working occupations. It is believed that the very small difference in knowledge among the needs of occupations does not present any problems for educators in terms of curriculum development.

Null Hypothesis 7

It was hypothesized that no significant opinion differences can be found in the skill expectation among sheet metal related occupations.

Conclusion 7

Based on the results of the analyses reported in Chapter IV, the conclusion is drawn that the required skills are quite different among occupations. Therefore, the Null Hypothesis was rejected. Most sheet metal occupations have consistent skills, meaning that the sheet metal department graduates who want to find jobs in particular occupations, should attain some particular cluster of skills. But it is difficult to find the consistent skills within the cold metal working occupation. It is probable that many industries, for example manufacturing, construction, or service, employ cold metal skilled workers. Therefore, cold metal skilled workers will acquire different skill background when they enter the labor market. Thus, curriculum for this particular occupation should include training with broad and basic entry level skills that enable students to succeed and then obtain further in-service training in the specific industry.

Null Hypothesis 8

It was hypothesized that no significant differences in opinions existed among skilled workers, supervisors, and teachers regarding the extent of knowledge necessary for different occupations.

Conclusion 8

Based on the results of the analyses reported in Table 29 (Chapter IV), there is sufficient evidence to reject the

Null Hypothesis. In Tables 95 through 104 (Appendix C), Scheffe's Multiple Range Tests for all significant F-values indicate that the ratings of the teachers are significantly higher than those of skilled workers and supervisors. These results are similar to those found regarding Null Hypothesis 4.

Tables 95, 98, and 103, which contain knowledge of mechanical materials, numerical control, and pressworking illustrate that the ratings of supervisors are higher than those of skilled workers. The evidence also indicates that knowledge of automatic manufacturing and of the use of appropriate materials received higher ratings from supervisors. These results may indicate future trends within the sheet metal industry.

The mean of welding technology is the highest among all the levels of knowledge, which suggests that not only skill but also knowledge of welding is most important in the sheet metal related occupations. Ratings of welding technology are higher than three, which means that the welding curriculum needs to be emphasized to considerable extent to meet the needs of industry.

Recommendations

Regarding the Curriculum Standards of the sheet metal department announced by Ministry of Education in Taiwan, R.O.C., the following recommendations are suggested.

1. To provide more knowledge based courses to sheet metal students in schools. The findings indicate that teachers and supervisors recognize that knowledge in numerical control working, materials, and welding technology are important in their jobs. These are knowledge based courses, which implies that students should acquire a firm knowledge foundation, such as computer and materials, to establish their broad-based education background.

2. Some skills or knowledge can be dropped from the curriculum, or emphasized to a lesser degree: Auto body working skills, namely sheet metal stretching and compression wrinkling, panel replacement, and corrosion protection and painting, are emphasized only by this specific occupation. It is not necessary to teach such skills to all sheet metal students.

3. Soldering and brazing skills, rivet working, thick plate gas welding, spinning, and mechanics are not expected competencies in the sheet metal industry, and can thus be dropped from the Curriculum Standards.

4. Parallel development, radial line development, and triangulation development methods are important skills within the sheet metal industry. Nevertheless, the findings indicate that these skills were overemphasized in the Curriculum Standards. Less emphasis would give the opportunity to study other useful skills and knowledge.

5. Certain skills and knowledge should be emphasized in performing sheet metal occupation jobs. Sheet metal bending, gas cutting, flat arc welding, numerical control, welding technology, and mechanical materials are highly important competencies within the sheet metal industry.

The findings indicate that most competencies in these areas acquired by respondents in schools are unsufficient. More emphasis on these areas would enable students to attain higher performance in their jobs.

Regarding the curriculum structure of the sheet metal department, the following recommendations are suggested.

1. The Labor Committee Institution in Taiwan, R.O.C. should review and reanalyze the job descriptions listed in the Dictionary of Occupational Titles published by the R.O.C. Only three respondents are in the plumbing and piping occupation in this study. This fact indicates that the skill contents taught in the sheet metal department in high schools are quite different from the those of plumbing and piping occupation. It is not suitable to list the plumbing and piping occupation as one of the sheet metal related occupations in the Dictionary of Occupation Titles.

2. The Ministry of Education in R.O.C. should separate the sheet Metal department into two departments. The findings indicate that there are two broad categories existing in the sheet metal industry: light gage sheet metal and heavy plate. Although both of these share some basic skills in common, different in-depth skills are emphasized by these two categories. Students could learn common basic skills and knowledge in the first year, then select either the light gage sheet metal or the heavy plate curriculum to learn entry level skills and knowledge in the second and third year. These changes should fit the present curriculum structure policy implemented in Taiwan, R.O.C.

3. Flexible educational system and coordination of vocational training system should be established. The findings indicate that skill contents and knowledge of the auto body sheet metal working occupation are similar to those of the sheet metal related industry, but some skills, such as panel replacement, corrosion protection and painting, have only specific applications to this specific occupation. A similar phenomenon occurs

in the plate metal cold working occupation. From the standpoints of equipment and labor market demand, it is difficult to provide such a special curriculum and equipment to students. An approach to this problem is to coordinate these programs with the vocational training centers. Students can learn the particular skills in vocational training centers, and study common skills and knowledge in schools.

4. The Ministry of Education of R.O.C. should provide a greater selection of courses to students. The findings indicate that it was difficult to determine skill requirements for the plate metal cold working occupation. This means that this specific occupation exists within many various industries. When students enter different industries, they should have some special skills. Greater selection of courses would enable students to acquire entry level job skills for their specific occupation.

BIBLIOGRAPHY

Arieh, L. (1977). Handbook of curriculum evaluation. New York: Longman.

Arizona Department of Education. (1984). Arizona vocational education competency-based vocational education model. Phoenix, AZ: Vocational Education Division.

Arnow, P. (1968). Report on manpower requirements, resources, utilization, and training. Washington, DC: U.S. Department of Labor.

Arthur, D., & Christine, M. R. (1987, Summer). Curricular reform. Phi Kappa Phi Journal, 67(3), 2-4.

Beauchamp, G. A. (1961). Curriculum theory. Wilmette, IL: Kagg.

Beauchamp, G. A. (1982). Curriculum theory: Meaning, development, and use. Theory into Practice, 17(3), 6-21.

Blank, W. E. (1987). A statewide system for competency-based instruction. Journal of Industrial Teacher Education, 24(4), 36-46.

Bohrnstedt, W. G., & Knoke, D. (1982). Statistics for social data analysis. Itasca, IL: F. E. Peacock.

Borg, W. R., & Gall, M. D. (1983). Educational Research, An Introduction (4th ed). New York: Longman.

Buttram, J. L., Kershner, L. M., Rioux, S., & Dusewicz, R. A. (1987). An evaluation of competency-based vocational education in Pennsylvania: Five years later. Journal of Vocational Education Research, 12(4), 35-55.

Carpenter, K. F. (1968). Competencies needed for common tasks in three home related occupations. Unpublished Master's thesis, Iowa State University, Ames, IA.

Choate, P. (1986). Looking forward: Jobs and workers. In D. F. Burton, Jr., J. M. Filer, D. A. Fraser, & R. Marshall, The jobs challenge (pp. 85-102). Cambridge, MA: Ballinger.

Clausen, O. C. (1976). Evaluation of the agricultural education curriculum. Unpublished thesis, Iowa State University, Ames, IA.

Cliett, T. A. (1975, October). Making the most of CETA. American Vocational Journal, 50(7), 35-58.

Copa, G. H., & Irvin, D. E., Jr. (1975, October). Manpower information versus decision-making needs. American Vocational Journal, 50(7), 41-42.

Crawford, L. C. (1977). A competency pattern approach to curriculum construction in distributive teacher education. Final report. Blacksburg, VA: Department of Education.

Cunningham, J. W. (1969). A conceptual framework for the study of job similarities. (Report CE 011400). Salem, OR: Oregon State Department of Education. (ERIC ED 262 129)

Dewey, J. (1940). My pedagogic creed. In J. Ratner (Ed.), Education today (pp. 1-17). New York: G. P. Putnam's Sons.

Dobry, A. (1969, October). Occupational programs in home economic--What is our commitment? What ought to be our focus? American Vocational Journal, 44(7), 56-58.

Doll, R. C. (1986). Curriculum improvement: Decision making and process (6th ed.). Boston, Mass.: Allyn and Bacon.

Eggland, S. A., & Williams, J. W. (1975, October). Manpower planning for marketing and distribution. American Vocational Journal, 50(7), 48-50.

Evans, R. N., & Herr, E. L. (1978). Fundations of vocational education (2nd ed.). Columbus, OH: Charles E. Merrill.

Finch, C. R., & Crunkilton, J. R. (1984). Curriculum development in vocational and technical education--Planning content and implementation (2nd ed.). Newton, MA: Allyn & Bacon.

Florida Department of Education. (1983). Individualized competency-based vocational education. Tallahassee, FL: Division of Adult, Vocational and Community Education.

Fraser, D. A. (1986). A challenge to the United States: Job creation and employment security. In D. F. Burton, Jr., J. H. Filer, D. A. Fraser, & R. Marshall, The jobs challenge (pp. 11-25). Cambridge, MA: Ballinger.

Fretwell, D. H. (1987). Challenges to implementing competency-based vocational training programs in developing countries. Journal of Industrial Teacher Education, 24(4), 47-51.

Fryklund, C. V. (1970). Occupational analysis: Techniques & procedures. New York: Beverly Hills.

Gael, S. (1983). Job analysis. San Francisco: Jossey-Bass.

Hopkins, C. O. (1975, October). Statewide manpower planning for Voc Ed. American Vocational Journal, 50(7), 43-45.

Houston, W. R., & Howsam, R. B. (1972). Competency-based teacher education: Progress, problems, and prospects. Chicago: Science Research Associates.

Howsam, R. B. (1972). Performance-based instruction. Today's Education, 61(4), 33-40.

Hunkins, F. P., & Ornstein, A. C. (1988, September). Designing the curriculum. NASSP Bulletin, 72(9), 50-59.

Islam, N. (1985). A critique and synthesis of curriculum theories to develop a paradigm for curriculum planning in the developing countries. (Doctoral dissertation, University of Kansas, 1984). Dissertation Abstracts International, 45(08), 2376A.

International Labour Office. (1969). International standard classification of occupations. Geneva: International Labour Office.

Johnson, M., & Taylor, P. H. (1974). Curriculum development- A comparative study. New York: Humanities.

Johnson, R. (1984). Occupation training families. Their implications for FE. (Report No. ISBN-0-946469-62-8). London. (ERIC Document Reproduction Service No. ED 253 657)

Kenneke, L. J. (1985, August). Industry panel curriculum project-Final report. (Report No. CE 042647). Corvallis, Oregon: Oregon State University, Vocational Technical Education Department. (ERIC Document Reproduction No. ED 262 234)

Kidder, D. E. (1972). Review and synthesis of research on manpower forecasting for vocational-technical education. Information Series No. 54. Columbus, OH: The Center for Vocational and Technical Education, The Ohio State University.

Kilpatrick, W. H. (1983). The case for progressivism in education. In G. Hass (Ed.), Curriculum planning: A new approach (4th ed.) (pp. 24-27). Boston, MA: Allyn and Bacon.

Kistler, A. (1975, October). A finger on the pulse. American Vocational Journal, 50(7), 36-37.

Klein, M. F. (1986). Alternative curriculum conceptions and designs. Theory into Practice, 25(6), 31-35.

Knaak, W. C. (1977). Competency-based vocational education: A review. Columbus, OH: National Center for Research in Vocational Education.

Kruger, D. H. (1975, October). Manpower planning & the local job economy. American Vocational Journal, 50(7), 32-35.

Leontief, W. (1986). Technological change, employment the rate of return on capital and wages. In D. F. Burton, Jr., J. H. Filer, D. A. Fraser, & R. Marshall, The jobs challenge (pp. 47-54). Cambridge, Massachusetts: Ballinger.

Little, R. (1985). Metal cluster brief, Vocational education in Oregon. Salem, OR: Oregon State Department of Education. (ERIC Document Reproduction Service No. ED 253 760)

Macdonald, J. B. (1977). Values bases and issues for curriculum. In A. Molnar, & J. A. Zahorik, Curriculum theory. Washington, D.C.: Association for Supervision and Curriculum Development.

Maley, D. (1975). Cluster concept in vocational education. Chicago: American Technical Society.

Mangum, G. L. (1975, October). A new ballgame under CETA. American Vocational Journal, 50(7), 32-33.

Mager, F. R. (1984). Measuring instructional results (2nd ed.). Belmont, CA: Pitman Learning.

McCutcheon, G. (1982). What in the world is curriculum theory? Theory into Practice, 21(1), 18-22.

McCutcheon, G. (1985). Curriculum theory/ curriculum practice: A gap or the grand canyon. In ASCD yearbook. Current thought on curriculum (pp. 45-52). Alexandria, VA: Association for Supervision and Curriculum Development.

McNamara, J. F. (1971, March). A mathematical programming approach to state-local program planning in vocational education. American Educational Research Journal, 8(2), 335-363.

Medley, D. M., Coker, H., & Soar, R. S. (1984). Measurement-based evaluation of teacher performance: An empirical approach. New York: Longman.

Meyer, C. F., Moore, C. G., Steele, L. G., & Vaughan, E. C. (1986). Implementing competency-based vocational education in South Carolina. Columbia, SC: South Carolina State Department of Education. (ERIC Document Reproduction Service No. ED 273786)

Miles, D. T., & Robinson, R. E. (1971). Behavior objectives: An even closer look. Educational Technology, 11(6), 39-44.

Missouri Department of Elementary and Secondary Education. (1984). Excellence through instructional management. Jefferson City, MO: Division of Career and Adult Education.

Molnar, A., & Zahorik, J. A. (1977). Curriculum theory, Washington, D. C.: Association for Supervision and Curriculum Development.

Newmann, F. M. (1988, January). Can depth replace coverage in the high school curriculum. Phi Delta Kappan, 69(5), 345-348.

Ohanneson, G., & Vanghan, G. (1975, October). The collection and use of vocational program information.

American Vocational Journal, 50(7), 36-37.

Oregon Occupational Information Coordinating Committee. (1985a, July). A project to review the vocational cluster system- summary of findings and recommendations. (Report No. CE 042545). Salem, OR: Oregon State Department of Education. (ERIC ED 262 180)

Oregon Occupational Information Coordinating Committee. (1985b, July). A review the vocational cluster system. Final report. (Report CE 042544). Salem, OR: Oregon State Department of Education. (ERIC ED 262 179)

Organization for Economic Co-operation and Development. (1975). Handbook on curriculum development. Paris, France: Centre for Educational Research and Innovation.

Organization for Economic Co-operation and Development. (1986). Flexibility in the labour market-the current debate. Paris, France: Head of Publication Service, OECD.

Ornstein, A. A. (1988, September). The irrelevant curriculum: A review from four perspectives. NASSP Bulletin, 72(9), 27-32.

Ott, L. (1988). An introduction to statistical methods and Analysis (3rd ed.). Boston: PWS-KENT.

Palardy, J. M., & Eisele, J. E. (1972). Competency based education. The Clearing House, 46(9), 545-548.

Peters, R. O. (1981). Curriculum models, staff development models and more models. (ERIC ED 197 836).

Petty, M. E. (1984, Spring). The making of vocational curriculum. Technical Education News, 43(2), 7-8.

Poland, R. (1975, October). Manpower planning and curriculum construction. American Vocational Journal, 50(7), 51-52.

Polk, E. S. (1982). Competency-based vocational education: Analysis of an educational bandwagon. Honolulu, HI: University of Hawaii.

Popham, W. J., & Baker, E. I. (1970). Systematic instruction. Englewood Cliffs, NJ: Prentice-Hall.

Roscore, T. J. (1975). Fundamental research statistics for the behavioral sciences. New York: Holt, Rinehart & Winston.

Schwab, J. J. (1978). The practical: A language for curriculum. In I. Westbury and N. J. Wilkof (Eds.), Science, curriculum, and liberal education: Selected essays (pp. 287-384). Chicago: The University of Chicago Press.

Shane, J. G., & Shane, H. G. (1973). Ralph Tyler discusses behavioral objectives. Today's Education, 62(6), 41-46.

Shanker, A. (1986). Business and schools: the inevitable partnership. In D. F. Burton, Jr., J. H. Filer, D. A. Fraser, & R. Marshall, The jobs challenge (pp. 189-197). Cambridge, MA: Ballinger.

Short, E. C. (1983). The forms and use of alternative curriculum development strategies: Policy implications. Curriculum Inquiry, 13(1), 43-64.

Short, E. C. (1984). The use of a curriculum development strategies matrix. Journal of Curriculum Studies, 15(2), 212-214.

Slocum, W. L. (1974). Occupational careers -- a sociological perspective (2nd ed.). Chicago: Aldine.

Smith, A. W. (1979). Generic skills, tredc families, base on data on the use of 588 tool skills from 1600 works and supervisors in 131 occupations. Ottawa, Canada: Canadian Commission of Employment and Immigration. (ERIC Document Reproduction Service No. ED 220 577)

Spellman, R. (1986). Education and training initiatives in the United Kingdom and macroeconomic policies. In D. F. Burton, Jr., J. H. Filer, D. A. Fraser, & R. Marshall, The jobs challenge (pp. 205-225). Cambridge, MA: Ballinger.

Staley, E. (1971). Planning occupational education and training for development. New York: Praeger.

Taba, H. (1962). Curriculum development- theory and practice. New York: Harcourt, Brace, and World.

Tanner, D., & Tanner, L. N. (1980). Curriculum development: Theory into Practice. (2nd ed.). New York: Macmillan.

Tyler, R. W. (1949). Basic principles of curriculum and instruction. Chicago: The University of Chicago Press.

Tyler, R. W. (1987, Summer). Examining the current demands for curricular reforms from a historical perspective. Phi Kappa Phi Journal, 67(3), 12-16.

Vallance, E. (1982). The practical uses of curriculum theory. Theory into Practice, 21(1), 4-10.

Venn, G. (1978, September). Vocational viewpoints: A message for school administrators. Vocational Education Journal, 53(6), 71-72.

Weagraff, P. J. (1974, Spring). The cluster concept: Development of curriculum materials for the public service occupations cluster. The Journal of Research and Development in Education, 7(3), 45-54.

Whitener, S. D. (1986, Spring). One answer for program improvement. VICA Professional Edition, 21(2), 8-11.

Wolansky, W. D. (1973, Winter). Career education- A National concern for the Improvement of education. Journal of Industrial Teacher Education, 10(2), 34-41.

Wolansky, W. D., & DaVall, J. B. (1982). Clustering-- a tool for developing vocational education curricula. Occupational Education Forum, 11(2), 1-18.

Wolfson, B. J. (1985). Psychological theory and curricular thinking. In ASCO Yearbook, Current Thought on Curriculum (pp. 53-72). Alexandria, VA: Association for Supervision and Curriculum Development.

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The Iowa State University Committee on the Use of Human Subjects in Research reviewed this project and concluded that the rights and welfare of the human subjects were adequately protected, that risks were outweighed by the potential benefits and expected value of the knowledge

sought, that confidentiality of data was assured and that informed consent was obtained by appropriate procedures.

APPENDIX A. LETTERS AND QUESTIONNAIRES

Iowa State University of Science and Technology Ames, Iowa 50011

December 4, 1989

Dear Sir/Madam:

I am a graduate student pursuing a Ph.D. degree in Industrial Education and Technology here at Iowa State University. To meet the requirements for my degree, I am proposing to conduct a study with the objective of comparing the competencies acquired in industrial/vocational senior high schools in Taiwan, Republic of China and those expected by employers.

It is hoped that the results of my study will provide useful information to the government to serve as a data base for amending the existing curriculum standard.

In order to carry out my study, I shall seek the opinions of teachers and students who graduated from high schools like you. May I, therefore, respectfully request your participation. All individual information will be kept confidential.

It is hoped that you will volunteer to participate in the project. Attachment enclosed is questionnaire, and a stamped and addressed envelope for the return of the completed questionnaire.

Your cooperation will be highly appreciated.

Sincerely,

Tien Chen-Jung

Tien, Chen-Jung

William Wolansky

William D. Wolansky, (Supervisor)
Professor of Industrial Education & Technology

INSTRUCTIONS FOR ASSESSING THE NEED FOR COMPETENCIES

for employees

A. The Curriculum Standard of Sheet Metal Department announced by the Ministry of Education is to make students employable at the entry level. This questionnaire deals with the competency requirements of sheet-metal industry. The results will provide useful information to the government to serve as a reference in amending the existing curriculum standard.

B. The current curriculum standard includes: 1. common courses such as Chinese, English, Mathmetics, ..., 2. fundamental courses such as Mechanical Manufacturing, Introduction of Electricity, Mechanical Drawing I, II, and III; Principles of Machine Elements, Mechanism, Introduction of Hydraulics, 3. sheet-metal related courses, and 4. selective courses. We assume that the common courses and fundamental courses are necessary. This research only deals with the sheet-metal related courses and skills.

C. Please rate the extent to which these objectives "were taught in your school" and are "currently needed" in performing your job. For example:

	currently needed low				high	taught in school low				high
	1	2	3	4	5	1	2	3	4	5
understanding identifying and selecting an electrode	_	_	_	_	x	_	x	_	_	_

The example above means that the competency is highly needed in performing your job currently, but it was inadequately taught in school.

D. Please make an effort to rate every item.
Your help will contribute the development of industrial education in Taiwan, R.O.C.

PERSONAL INFORMATION SHEET

All information will be kept confidential.

No. of employees (approximate):__________

Length of time since you graduated from vocational high school:

1:__ < 1 year; 2:__ 1 - 3 years; 3:__ 3 - 5 years; 4:__ > 5 years

Length of time in present position:

1:__ < 1 year; 2:__ 1 - 3 years; 3:__ 3 - 5 years; 4:__ > 5 years

Education background: 1:4 year college ____, 2:Junior college ____,

Your occupation: (please mark most appropriate "**one**")

1. ____ General sheet-metal (bending, assembling, air conditioning, furniture making, and instrument box making of sheet-metal)
2. ____ Auto body sheet-metal (auto body repair and manufacture)
3. ____ Sheet-metal plastic forming (pressworking, spinning, bending, drawing and others)
4. ____ Platemetal cold working (forming and assembling of strip steel, and thick metal plate)
5. ____ welding working (working on every kind of welding)
6. ____ Piping or plumbing.

Your title (please mark most appropriate "**one**")

1. ____ supervisor, 2. ____ skilled worker,

3. ____ other, please write: ____________________

INSTRUCTIONS FOR ASSESSING THE NEED FOR COMPETENCIES

for teathers

A. The Curriculum Standard of Sheet Metal Department announced by the Ministry of Education is to make students employable at the entry level. This questionnaire deals with the competency requirements of sheet-metal industry. The results will provide useful information to the government to serve as a reference in amending the existing curriculum standard.

B. The current curriculum standard includes: 1. common courses such as Chinese, English, Mathmetics, ..., 2. fundamental courses such as Mechanical Manufacturing, Introduction of Electricity, Mechanical Drawing I, II, and III; Principles of Machine Elements, Mechanism, Introduction of Hydraulics, 3. sheet-metal related courses, and 4. selective courses. We assume that the common courses and fundamental courses are necessary. This research only deals with the sheet-metal related courses and skills.

C. Please rate the extent to which these objectives "currently taught in your school" and are "should be taught" in performing sheet metal job. For example:

	currently taught					should be taught				
	low				high	low				high
	1	2	3	4	5	1	2	3	4	5
understanding identifying and selecting an electrode	_	x	_	_	_	_	_	_	x	_

The example above means that the competency is highly needed in performing the job currently, but it is inadequately taught in school.

D. Please make an effort to rate every item.
Your help will contribute the development of industrial education in Taiwan, R.O.C.

PERSONAL INFORMATION SHEET

All information will be kept confidential.

Do you graduate from vocational high school?

1. yes ____ 2. no ____

Length of time in present position (teacher):

1:__ <3 years; 2:__ 3-5 years; 3:__ 5-10 years; 4:__ >10 years

PART ONE

Skill in	currently needed					taught in school				
	low				high	low				high
	1	2	3	4	5	1	2	3	4	5
general forming (light-gage less than 3 mm thick)										
1. sheet metal rolling	_	_	_	_	_	_	_	_	_	_
2. sheet metal bending	_	_	_	_	_	_	_	_	_	_
3. sheet metal seam working	_	_	_	_	_	_	_	_	_	_
4. rivet working	_	_	_	_	_	_	_	_	_	_
5. complex objects layout and assembling	_	_	_	_	_	_	_	_	_	_
development method										
1. parallel line development	_	_	_	_	_	_	_	_	_	_
2. radial line development	_	_	_	_	_	_	_	_	_	_
3. triangulation development	_	_	_	_	_	_	_	_	_	_
auto body working										
1. basic sheet metal stretching and compression wrinkling	_	_	_	_	_	_	_	_	_	_
2. advanced sheet metal stretching and compression wrinkling	_	_	_	_	_	_	_	_	_	_
3. panel replacement	_	_	_	_	_	_	_	_	_	_
4. corrosion protection and painting	_	_	_	_	_	_	_	_	_	_
gas welding (cutting)										
1. thin plate (< 2 mm) butt welding	_	_	_	_	_	_	_	_	_	_
2. thin plate lap welding	_	_	_	_	_	_	_	_	_	_
3. thick plate (> 2 mm) flat welding	_	_	_	_	_	_	_	_	_	_
4. thick plate vertical welding	_	_	_	_	_	_	_	_	_	_
5. thick plate horizontal welding	_	_	_	_	_	_	_	_	_	_
6. gas cutting	_	_	_	_	_	_	_	_	_	_
arc welding										
1. flat position	_	_	_	_	_	_	_	_	_	_
2. horizontal position	_	_	_	_	_	_	_	_	_	_
3. vertical position	_	_	_	_	_	_	_	_	_	_
4. overhead position	_	_	_	_	_	_	_	_	_	_
5. corner joints	_	_	_	_	_	_	_	_	_	_
6. pipe welding	_	_	_	_	_	_	_	_	_	_
7. gas tungsten arc welding	_	_	_	_	_	_	_	_	_	_
8. gas metal arc welding	_	_	_	_	_	_	_	_	_	_
9. submerged arc welding	_	_	_	_	_	_	_	_	_	_
soldering and brazing										
1. soldering	_	_	_	_	_	_	_	_	_	_
2. basic brazing	_	_	_	_	_	_	_	_	_	_
3. advanced brazing	_	_	_	_	_	_	_	_	_	_

	currently needed low 1	2	3	4	high 5	taught in school low 1	2	3	4	high 5
resistance welding										
sheet metal pressworking										
1. bending										
2. drawing										
3. spinning										
basic bench working										
cold metal working										
1. heavy-gage metal layout and cutting										
2. heavy-gage metal forming										
3. construction working										
4. heavy-gage metal complex layout and forming										
plumbing and piping										
1. plastic piping										
2. steel piping										
3. copper piping										
welding inspection										
1. destructive inspection										
2. X ray inspection										
3. ultrasonic wave inspection										
4. other pipe inspection										
numerical control working										
1. software working										
2. setup and operation										

PART TWO

<u>Understanding of</u>	currently needed low 1	2	3	4	high 5	taught in school low 1	2	3	4	high 5
mechanical materials										
1. machanical properties of metal										
2. steel manufacturing processing										
3. specifications and categories										
4. equilibrium diagrams of steel										
5. heat treatment of steel										
6. categories and properties of alloy steel										
7. categories and properties of cast iron										

	currently needed low				high	taught in school low				high
	1	2	3	4	5	1	2	3	4	5
8. categories and properties of copper and copper alloys	_	_	_	_	_	_	_	_	_	_
9. introduction of Al, Mg, Ti, and nonferrous alloys	_	_	_	_	_	_	_	_	_	_
10. introduction of nonmetal materials	_	_	_	_	_	_	_	_	_	_
11. others:________________										
welding technology										
1. welding safety	_	_	_	_	_	_	_	_	_	_
2. theory and procedure of soldering and brazing	_	_	_	_	_	_	_	_	_	_
3. theory and procedure of oxy-accetelene welding, cutting	_	_	_	_	_	_	_	_	_	_
4. theory and categories of arc welding	_	_	_	_	_	_	_	_	_	_
5. identify and select electrode	_	_	_	_	_	_	_	_	_	_
6. welding symbol and term	_	_	_	_	_	_	_	_	_	_
7. defects, deformation and protection	_	_	_	_	_	_	_	_	_	_
8. special welding procedure	_	_	_	_	_	_	_	_	_	_
9. welding inspection	_	_	_	_	_	_	_	_	_	_
10. weld joint design	_	_	_	_	_	_	_	_	_	_
11. others:________________										
heat treatment										
1. transformation of iron	_	_	_	_	_	_	_	_	_	_
2. equilibrium diagram of steel	_	_	_	_	_	_	_	_	_	_
3. safety and equipment of heat treatment	_	_	_	_	_	_	_	_	_	_
4. isothermal transformation diagram	_	_	_	_	_	_	_	_	_	_
5. surface hardening	_	_	_	_	_	_	_	_	_	_
6. annealing, nomalizing, quenching and tempering of steel	_	_	_	_	_	_	_	_	_	_
7. working hardening and recrystalization	_	_	_	_	_	_	_	_	_	_
8. deformation and cracking	_	_	_	_	_	_	_	_	_	_
9. heat treatment of nonferrous	_	_	_	_	_	_	_	_	_	_
10. inspection (destructive and nondestructive)	_	_	_	_	_	_	_	_	_	_
11. others:________________										
introduction of pressworking										
1. basic theory of pressworking	_	_	_	_	_	_	_	_	_	_
2. categories of pressworking	_	_	_	_	_	_	_	_	_	_
3. safety of pressworking	_	_	_	_	_	_	_	_	_	_
4. equipment of pressworking	_	_	_	_	_	_	_	_	_	_
5. compression force and metal flow	_	_	_	_	_	_	_	_	_	_
6. cutting of sheet metal	_	_	_	_	_	_	_	_	_	_
7. bending of sheet metal	_	_	_	_	_	_	_	_	_	_

	currently needed					taught in school				
	low				high	low				high
	1	2	3	4	5	1	2	3	4	5
8. embossing of sheet metal	_	_	_	_	_	_	_	_	_	_
9. drawing of sheet metal	_	_	_	_	_	_	_	_	_	_
10. die design technique	_	_	_	_	_	_	_	_	_	_
11. others:__________________										
piping and plumbing										
1. introduction to piping	_	_	_	_	_	_	_	_	_	_
2. selection of pipe	_	_	_	_	_	_	_	_	_	_
3. categories and function of valves	_	_	_	_	_	_	_	_	_	_
4. identify the terms and code	_	_	_	_	_	_	_	_	_	_
5. standards for piping	_	_	_	_	_	_	_	_	_	_
6. piping specification	_	_	_	_	_	_	_	_	_	_
7. pressure drop in piping system and line sizing	_	_	_	_	_	_	_	_	_	_
8. piping drafting procedures	_	_	_	_	_	_	_	_	_	_
9. piping design	_	_	_	_	_	_	_	_	_	_
10. others:__________________										
sheet metal plastic forming										
1. basic theory of plastic deformation	_	_	_	_	_	_	_	_	_	_
2. microstructure of plastic deformation metal	_	_	_	_	_	_	_	_	_	_
3. working hardening and recrystalization	_	_	_	_	_	_	_	_	_	_
4. forging processing and equipment	_	_	_	_	_	_	_	_	_	_
5. extrusion procession and equipment	_	_	_	_	_	_	_	_	_	_
6. rolling processing and equipment	_	_	_	_	_	_	_	_	_	_
7. drawing processing and equipment	_	_	_	_	_	_	_	_	_	_
8. spinning processing and equipment	_	_	_	_	_	_	_	_	_	_
9. bending processing and equipment	_	_	_	_	_	_	_	_	_	_
10. high enery forming	_	_	_	_	_	_	_	_	_	_
11. others:__________________										
mechanics										
1. basic concept, units, vector	_	_	_	_	_	_	_	_	_	_
2. addition and resolution of vector	_	_	_	_	_	_	_	_	_	_
3. principle and application of couple and moment	_	_	_	_	_	_	_	_	_	_
4. principle and application of gravity center and centroids	_	_	_	_	_	_	_	_	_	_
5. principle and application of friction	_	_	_	_	_	_	_	_	_	_

	currently needed low 1	2	3	4	high 5	taught in school low 1	2	3	4	high 5
6. principle and application of simple motion										
7. principle and application of curvilinear motion										
8. principle and application of harmonic motion (spring)										
9. kinetic energy, potential energy, and efficiency										
10. principle and application of momentum										
11. others:________										

material mechanics

	currently needed low 1	2	3	4	high 5	taught in school low 1	2	3	4	high 5
1. stress, strain and tensile strength, curve										
2. elastic deformation, plastic deformation										
3. thermal stress (residual strss)										
4. principle and application of shear stress and strain)										
5. stress analysis of riveting and welding										
6. principle and application of inertia moment										
7. shear stress and bending moment of beam										
8. defection of beam and application										
9. principle and application of torsion										
10. combimation stress (tension, compression, torsion, bending)										
11. others:________										

numerical control skill

	currently needed low 1	2	3	4	high 5	taught in school low 1	2	3	4	high 5
1. concept of automation										
2. economy of numerical control										
3. types of NC machine										
4. principle of NC										
5. procedure of NC										
6. machine axes										
7. software: punched card and magnetic tape										
8. three axes machine										
9. basic computer programming										
10. future of NC										
11. others:________										

	currently needed low 1	2	3	4	high 5	taught in school low 1	2	3	4	high 5
air conditioning										
1. basic principle of air conditioning	_	_	_	_	_	_	_	_	_	_
2. concept of air flow	_	_	_	_	_	_	_	_	_	_
3. principle of heat transfer	_	_	_	_	_	_	_	_	_	_
4. concept of refrigeration	_	_	_	_	_	_	_	_	_	_
5. equipment of air condition system	_	_	_	_	_	_	_	_	_	_
6. calculation of air condition load	_	_	_	_	_	_	_	_	_	_
7. electricity and control system of air conditioning	_	_	_	_	_	_	_	_	_	_
8. isolate materials	_	_	_	_	_	_	_	_	_	_
9. air conditioning for special environment	_	_	_	_	_	_	_	_	_	_
10. design of air condition system	_	_	_	_	_	_	_	_	_	_
11. others:________________										

板金行業能力評估問卷
畢業生用

1. 教育公佈的板金課程標準目的是希望學生畢業後能充分就業。此問卷是調查板金行業界對於就業者所具能力的需求。此項研究將可提供政府修訂課程時之重要參考依據。

2. 目前的課程標準包含：①共同科目；如國文、英文……；②基礎科目；如機械製造，電工概論，機械製圖一、二、三，機件原理、機構學、油壓概論；③板金相關科目；及④選修科目，此項研究係針對板金相關科目進行探討，其他部份不在探討之範圍。

3. 請在您目前工作上的需要及以前學校所教兩情況中圈選適當的分數。例如：

	目前工作需要 低　　　高 1 2 3 4 5	以前學校所教 低　　　高 1 2 3 4 5
例：正確分辨及選擇適當銲條	□□□□☒	☒□□□□

前例所示為目前您工作上需要此項知識能力的程度很高，但學校卻提供不足，使您這方面能力深感不足。

4. 請將每一題都惠予作答，您的協助對我國的板金教育及板金科的未來前途都有很大的貢獻，謝謝您的合作。

個人資料

（您個人的意見，我們將予以保密）

1. 工廠工人數（約）：

2. 高工畢業幾年？
   ①：□<1年， ②：□1－3年， ③：□3－5年 ④：□>5年

3. 擔任目前工作幾年？
   ①：□<1年， ②：□1－3年， ③：□3－5年 ④：□>5年

4. 最高畢業學歷：
   ①：□4年大學院校， ②：□專科， ③：高工

5. 您目前所從事的行業
   （請務必選擇一項最適合您的填答）

   (1)□ 一般板金工（含彎折、組合、空調管路、板金箱櫃傢俱製造、板金儀錶箱）。
   (2)□ 汽車板金工（各型汽車板金之修護及製造）。
   (3)□ 板金工塑性成型（冲床加工、板金旋壓、彎折、抽製，或其他類似工作）。
   (4)□ 冷作工（厚板之成型、組合、或角鐵、圓鐵、型鋼之成型加工）。
   (5)□ 銲接工（一般或特殊銲接法之銲接工作）。
   (6)□ 配管工。

6. 你所擔任的職務
   (1)□ 管理人員 (2)□ 現場工作人員
   (3)□ 其他人員；請詳填：

板金行業能力評估問卷
教師用

1. 教育公佈的板金課程標準目的是希望學生畢業後能充分就業。此問卷是調查板金行業界對於就業者所具能力的需求。此項研究將可提供政府修訂課程時之重要參考依據。

2. 目前的課程標準包含：①共同科目；如國文、英文……；②基礎科目；如機械製造，電工概論，機械製圖一、二、三，機件原理、機構學、油壓概論；③板金相關科目；及④選修科目，此項研究係針對板金相關科目進行探討，其他部份不在探討之範圍。

3. 請在您目前實際上的需要及目前學校所教兩情況中圈選適當的分數。例如：

	目前實際需要 低　　高 1 2 3 4 5	目前學校所教 低　　高 1 2 3 4 5
例：正確分辨及選擇適當鉚條	□□□□☒	☒□□□□

前例所示為目前您工作上需要此項知識能力的程度很高，但學校卻提供不足，使您這方面能力深感不足。

4. 請將每一題都惠予作答，您的協助對我國的板金教育及板金科的未來前途都有很大的貢獻，謝謝您的合作。

個人資料

（您個人的意見，我們將予以保密）

您是否畢業於高工板金科？ □ 是； □ 否

您擔任教師工作幾年？

①：□＜3年； ②：□3－5年； ③：□5－10年； ④：□＞10年

第一部分：技能

請您對目前各單項的技術需要性與學校所教的情況，予以塡答！

	目前工作需要 高　　低 1 2 3 4 5	以前學校所教 高　　低 1 2 3 4 5
一般板金工作（小於 3 mm之薄板金屬）	□□□□□	□□□□□
1.板金滾圓操作	□□□□□	□□□□□
2.板金折彎操作	□□□□□	□□□□□
3.板金接縫操作	□□□□□	□□□□□
4.鉚接操作	□□□□□	□□□□□
5.複雜板金工作物之展開與組合	□□□□□	□□□□□
板金展開法		
1.平行線展開法	□□□□□	□□□□□
2.放射線展開法	□□□□□	□□□□□
3.三角展開法	□□□□□	□□□□□
汽車板金工作		
1.基本打型板金之延展及縮收操作	□□□□□	□□□□□
2.複雜打型板金之延展及縮收操作	□□□□□	□□□□□
3.汽車板金之更換及安裝	□□□□□	□□□□□
4.汽車板金防銹處理及塗裝操作	□□□□□	□□□□□
氣銲（或氣體切割）		
1.薄板對接（小於 2 mm）	□□□□□	□□□□□
2.薄板搭接（小於 2 mm）	□□□□□	□□□□□
3.厚板對接（大於 2 mm）	□□□□□	□□□□□
4.厚板立銲	□□□□□	□□□□□
5.厚板橫銲	□□□□□	□□□□□
6.氣體切割	□□□□□	□□□□□

	目前工作需要 高 低 1 2 3 4 5	以前學校所教 高 低 1 2 3 4 5
電銲		
1.平銲	□□□□□	□□□□□
2.橫銲	□□□□□	□□□□□
3.立銲	□□□□□	□□□□□
4.仰銲	□□□□□	□□□□□
5.塡角銲	□□□□□	□□□□□
6.管銲	□□□□□	□□□□□
7.氬銲（TIG）	□□□□□	□□□□□
8.CO_2銲（MIG）	□□□□□	□□□□□
9.潛弧銲	□□□□□	□□□□□
錫銲及銅銲（軟銲及硬銲）		
1.錫銲操作	□□□□□	□□□□□
2.基本銅銲操作	□□□□□	□□□□□
3.進階銅銲操作	□□□□□	□□□□□
電阻點銲操作	□□□□□	□□□□□
板金冲床工作		
1.彎折操作	□□□□□	□□□□□
2.冲床操作	□□□□□	□□□□□
3.旋壓操作	□□□□□	□□□□□
基本鉗工工作	□□□□□	□□□□□
冷作工作		
1.厚板之展開及切割	□□□□□	□□□□□
2.厚板之成型操作	□□□□□	□□□□□
3.型鋼，結構用鋼之成型	□□□□□	□□□□□
4.複雜厚板之展開及成型	□□□□□	□□□□□

	目前工作需要 高　　　低 1 2 3 4 5	以前學校所教 高　　　低 1 2 3 4 5
配管工作		
1.塑膠管之成型，接合	□□□□□	□□□□□
2.鋼管之成型，接合	□□□□□	□□□□□
3.銅管之成型，接合	□□□□□	□□□□□
銲接檢驗		
1.破壞性檢驗法	□□□□□	□□□□□
2.X光檢驗法	□□□□□	□□□□□
3.超音波檢驗法	□□□□□	□□□□□
4.其他管路檢驗法	□□□□□	□□□□□
數值控制機工作		
1.軟體設計	□□□□□	□□□□□
2.安裝及操作	□□□□□	□□□□□

第二部分：知識

請您對目前相關知識的需要性與學校所教的情況予以塡答。

	目前工作需要 高　　　低 1 2 3 4 5	以前學校所教 高　　　低 1 2 3 4 5
機械材料		
1.金屬機械性質	□□□□□	□□□□□
2.鋼鐵製造程序	□□□□□	□□□□□
3.鋼鐵規格及分類	□□□□□	□□□□□
4.鋼鐵之平衡圖	□□□□□	□□□□□
5.鋼鐵之熱處理	□□□□□	□□□□□
6.合金鋼之種類及特性	□□□□□	□□□□□

	目前工作需要 高 低 1 2 3 4 5	以前學校所教 高 低 1 2 3 4 5
7.鑄鐵之種類及特性	□□□□□	□□□□□
8.銅及銅合金	□□□□□	□□□□□
9.鋁、鎂、鈦及其合金	□□□□□	□□□□□
10.非金屬材料	□□□□□	□□□□□
銲接工程學		
1.銲接安全	□□□□□	□□□□□
2.錫銲、銅銲、原理及方法	□□□□□	□□□□□
3.氧乙炔銲及切割原理	□□□□□	□□□□□
4.電銲原理及分類	□□□□□	□□□□□
5.銲條之分類及選擇	□□□□□	□□□□□
6.銲接符號及術語	□□□□□	□□□□□
7.銲接之缺陷、變形及防止	□□□□□	□□□□□
8.特殊銲接法（氬銲、CO_2銲、及其他）	□□□□□	□□□□□
9.銲道檢驗（破壞性及非破壞性）	□□□□□	□□□□□
10.銲道接頭設計	□□□□□	□□□□□
熱處理		
1.鋼鐵之變態	□□□□□	□□□□□
2.鋼鐵之平衡圖	□□□□□	□□□□□
3.熱處理設備及安全	□□□□□	□□□□□
4.恆溫變態曲線	□□□□□	□□□□□
5.退火、正常化、淬火，及回火	□□□□□	□□□□□
6.表面硬化法	□□□□□	□□□□□
7.加工硬化及再結晶溫度	□□□□□	□□□□□
8.鋼鐵之熱處理變形	□□□□□	□□□□□
9.非鐵金屬之熱處理	□□□□□	□□□□□
10.熱處理之檢驗（破壞性及非破壞性）	□□□□□	□□□□□
冲壓概論		
1.基本冲壓原理	□□□□□	□□□□□

	目前工作需要 高　　　低 1 2 3 4 5	以前學校所教 高　　　低 1 2 3 4 5
2.冲壓加工之安全	□□□□□	□□□□□
3.冲壓加工之種類	□□□□□	□□□□□
4.冲壓壓力及材料之流變	□□□□□	□□□□□
5.冲壓加工之設備	□□□□□	□□□□□
6.金屬板之冲剪原理	□□□□□	□□□□□
7.金屬板之彎曲原理	□□□□□	□□□□□
8.成型加工之原理	□□□□□	□□□□□
9.抽製加工之原理	□□□□□	□□□□□
10.冲模設計	□□□□□	□□□□□
工業配管		
1.配管簡介	□□□□□	□□□□□
2.管路選擇、分類	□□□□□	□□□□□
3.閥之種類及功能	□□□□□	□□□□□
4.配管符號及術語	□□□□□	□□□□□
5.配管之標準	□□□□□	□□□□□
6.配管規格及估算	□□□□□	□□□□□
7.管路系統之壓降及尺寸	□□□□□	□□□□□
8.配管製圖法	□□□□□	□□□□□
9.管路設計	□□□□□	□□□□□
板金塑性加工		
1.塑性加工之基本原理	□□□□□	□□□□□
2.塑性變形材料之微組織	□□□□□	□□□□□
3.加工硬化及再結晶	□□□□□	□□□□□
4.鍛造設備及方法	□□□□□	□□□□□
5.擠製設備及方法	□□□□□	□□□□□
6.輥壓設備及方法	□□□□□	□□□□□
7.抽拉設備及方法	□□□□□	□□□□□
8.旋壓設備及方法	□□□□□	□□□□□
9.彎曲加工設備及方法	□□□□□	□□□□□
10.高能量加工方法	□□□□□	□□□□□

	目前工作需要 高　　　低 1 2 3 4 5	以前學校所教 高　　　低 1 2 3 4 5
機械力學		
1.力學之觀念、單位，及向量	□□□□□	□□□□□
2.平面共點力之分解及合成	□□□□□	□□□□□
3.力偶、力矩原理及應用	□□□□□	□□□□□
4.重心、形心、質量中心之原理及應用	□□□□□	□□□□□
5.摩擦之種類原理及應用	□□□□□	□□□□□
6.直線運動之原理及應用	□□□□□	□□□□□
7.曲線運動之原理及應用	□□□□□	□□□□□
8.簡諧運動（彈簧、單擺）之原理及應用	□□□□□	□□□□□
9.動能、位能及機械效率	□□□□□	□□□□□
10.動量及衝量及應用	□□□□□	□□□□□
材料力學		
1.應力、應變、抗拉強度，及其曲線	□□□□□	□□□□□
2.彈性變形、塑性變形	□□□□□	□□□□□
3.熱應力（或殘留應力）	□□□□□	□□□□□
4.剪應力、應變的原理及應用	□□□□□	□□□□□
5.鉚接及銲接之應力分析	□□□□□	□□□□□
6.慣性矩之原理及應用	□□□□□	□□□□□
7.梁之剪力及彎曲力矩	□□□□□	□□□□□
8.梁之撓曲及應用	□□□□□	□□□□□
9.扭力之原理及應用	□□□□□	□□□□□
10.合成應力分析（拉伸、壓縮、扭力、彎曲之混合）	□□□□□	□□□□□
數值控制製技術		
1.自動化觀念	□□□□□	□□□□□
2.數值控制的經濟效益	□□□□□	□□□□□
3.數值控制機之種類	□□□□□	□□□□□
4.數值控制之原理	□□□□□	□□□□□
5.數值控制之程序	□□□□□	□□□□□
6.數值控制之加工軸	□□□□□	□□□□□

	目前工作需要 高　　　　低 1 2 3 4 5	以前學校所教 高　　　　低 1 2 3 4 5
7.數值控制之軟體製作	□□□□□	□□□□□
8.三向數值控制機	□□□□□	□□□□□
9.基本程式設計	□□□□□	□□□□□
10.數值控制之發展	□□□□□	□□□□□
空調原理		
1.空調之基本原理	□□□□□	□□□□□
2.空氣流之原理	□□□□□	□□□□□
3.熱交換機之原理	□□□□□	□□□□□
4.冷凍原理	□□□□□	□□□□□
5.空調系統之設備	□□□□□	□□□□□
6.空調負荷之計算	□□□□□	□□□□□
7.空調電路及控制系統	□□□□□	□□□□□
8.隔熱材料	□□□□□	□□□□□
9.特殊環境之空調	□□□□□	□□□□□
10.空調系統之設計	□□□□□	□□□□□

APPENDIX B. ANALYSIS OF VARIANCE

TABLE 30. Analysis of variance relating to the skill breadth among the occupations

Variance	Source	df.	SS	MS	F	Prob>F
Skill 1	Model	5	18.2	3.60	3.83*	0.0025
	Error	188	176.75	0.94		
Skill 2	Model	5	24.44	4.89	2.63	0.0252
	Error	188	394.77	1.86		
Skill 3	Model	5	99.86	19.97	15.01**	0.0001
	Error	188	250.13	1.33		
Skill 4	Model	5	14.04	2.80	2.38	0.0406
	Error	188	222.17	1.18		
Skill 5	Model	5	16.48	3.30	3.15*	0.0094
	Error	188	196.94	1.05		
Skill 6	Model	5	11.79	2.36	2.02	0.0772
	Error	188	219.04	1.66		
Skill 7	Model	5	92.60	18.52	8.34**	0.0001
	Error	188	417.32	2.22		
Skill 8	Model	5	33.68	6.74	5.00**	0.0003
	Error	188	253.28	1.35		
Skill 9	Model	5	4.49	0.90	0.49	0.7852
	Error	188	346.25	1.84		
Skill 10	Model	5	43.72	8.74	5.58**	0.0001
	Error	188	294.70	1.57		
Skill 11	Model	5	12.88	2.58	1.78	0.1195
	Error	188	272.50	1.45		
Skill 12	Model	5	32.36	6.47	4.14	0.0014
	Error	188	294.13	1.56		
Skill 13	Model	5	25.69	5.14	2.43	0.0363
	Error	188	396.69	2.11		

*p<.05, **p<.01.

TABLE 31. Analysis of variance relating to the knowledge requirements among the occupations

Variance	Source	df.	SS	MS	F	Prob>F
Know.1	Model	5	9.77	1.95	1.89	0.0976
	Error	188	194.23	1.03		
Know.2	Model	5	14.27	2.85	2.06	0.0718
	Error	188	259.98	1.38		
Know.3	Model	5	15.61	3.12	2.39	0.0398
	Error	188	245.94	1.31		
Know.4	Model	5	19.27	3.85	3.06	0.0112
	Error	188	222.17	1.18		
Know.5	Model	5	17.46	3.49	1.95	0.0879
	Error	188	336.50	1.79		
Know.6	Model	5	11.63	2.33	2.13	0.0632
	Error	188	204.85	1.09		
Know.7	Model	5	5.22	1.04	0.74	0.5914
	Error	188	263.54	1.40		
Know.8	Model	5	4.67	0.93	0.69	0.6287
	Error	188	252.92	1.35		
Know.9	Model	5	14.91	2.98	1.60	0.1626
	Error	188	350.85	1.87		
Know.10	Model	5	15.01	3.00	1.92	0.0925
	Error	188	293.61	1.56		

TABLE 32. Analysis of variance relating to the skills in general forming of light gage sheet metal

Variance	Source	df.	SS	MS	F	Prob>F
Skill 11	Model	6	103.53	17.25	8.92**	0.0001
	Error	256	495.33	1.93		
Skill 12	Model	6	110.43	18.40	9.48**	0.0001
	Error	256	497.11	1.94		
Skill 13	Model	6	70.57	11.76	5.21**	0.0001
	Error	256	577.50	2.56		
Skill 14	Model	6	45.68	7.61	4.83**	0.0001
	Error	256	403.75	1.58		
Skill 15	Model	6	40.51	6.75	3.09	0.0061
	Error	256	558.45	2.18		

** $p<.01$.

TABLE 33. Analysis of variance relating to the skills in development method

Variance	Source	df.	SS	MS	F	Prob>F
Skill 21	Model	6	130.18	21.70	10.27**	0.0001
	Error	256	540.97	2.11		
Skill 22	Model	6	117.69	19.61	9.46**	0.0001
	Error	256	531.00	2.07		
Skill 23	Model	6	74.45	12.41	5.30**	0.0001
	Error	256	599.35	2.34		

** $p<.01$.

TABLE 34. Analysis of variance relating to the skills in auto body working

Variance	Source	df.	SS	MS	F	Prob>F
Skill 31	Model	6	260.72	43.45	27.68^{**}	0.0001
	Error	256	401.88	1.57		
Skill 32	Model	6	98.74	16.46	10.37^{**}	0.0001
	Error	256	406.43	1.59		
Skill 33	Model	6	260.00	43.33	22.31^{**}	0.0001
	Error	256	497.26	1.94		
Skill 34	Model	6	242.05	40.34	20.02^{**}	0.0001
	Error	256	315.82	2.01		

$^{**}p<.01$.

TABLE 35. Analysis of variance relating to the skills in gas welding and cutting

Variance	Source	df.	SS	MS	F	Prob>F
Skill 41	Model	6	159.31	26.55	13.19^{**}	0.0001
	Error	256	551.34	2.01		
Skill 42	Model	6	67.08	11.18	5.83^{**}	0.0001
	Error	256	490.58	1.92		
Skill 43	Model	6	20.08	3.35	1.37	0.2263
	Error	256	624.43	2.44		
Skill 44	Model	6	12.21	2.03	0.90	0.4939
	Error	256	577.27	2.25		
Skill 45	Model	6	14.28	2.83	0.98	0.4368
	Error	256	619.37	2.42		
Skill 46	Model	6	37.02	6.17	3.34^{**}	0.0035
	Error	256	472.58	1.85		

$^{**}p<.01$.

TABLE 36. Analysis of variance relating to the skill in arc welding

Variance	Source	df.	SS	MS	F	Prob>F
Skill 31	Model	6	63.08	10.51	7.70^{**}	0.0001
	Error	256	349.41	1.36		
Skill 32	Model	6	33.70	5.62	3.16^{*}	0.0053
	Error	256	455.71	1.78		
Skill 33	Model	6	49.17	8.20	4.17^{**}	0.0005
	Error	256	503.49	1.97		
Skill 34	Model	6	11.49	1.92	0.96	0.4518
	Error	256	509.88	1.99		
Skill 35	Model	6	65.18	10.86	5.85^{**}	0.0001
	Error	256	475.03	1.86		
Skill 36	Model	6	79.12	13.19	6.73^{**}	0.0001
	Error	256	501.35	1.96		
Skill 37	Model	6	69.82	11.64	5.19^{**}	0.0001
	Error	256	573.46	2.24		
Skill 38	Model	6	47.41	7.90	3.92	0.0009
	Error	256	515.77	2.01		
Skill 39	Model	6	45.91	7.65	3.94^{**}	0.0024
	Error	256	560.77	2.19		

$^{*}p<.05$, $^{**}p<.01$.

TABLE 37. Analysis of variance relating to the skills in sheet metal pressworking

Variance	Source	df.	SS	MS	F	Prob>F
Skill 81	Model	6	140.29	23.38	11.75^{**}	0.0001
	Error	256	509.36	1.99		
Skill 82	Model	6	84.43	14.07	6.71^{**}	0.0001
	Error	256	536.83	2.10		
Skill 83	Model	6	40.45	6.74	3.56	0.021
	Error	256	484.94	1.89		

$^{**}p<.01$.

TABLE 38. Analysis of variance relating to the skills in cold metal working

Variance	Source	df.	SS	MS	F	Prob>F
Skill101	Model	6	88.02	14.67	7.52^{**}	0.0001
	Error	256	499.70	1.95		
Skill102	Model	6	99.27	16.54	8.67^{**}	0.0001
	Error	256	488.36	1.90		
Skill103	Model	6	59.46	9.91	5.03^{**}	0.0001
	Error	256	504.49	1.97		
Skill104	Model	6	49.83	8.31	4.39^{**}	0.0003
	Error	256	483.84	1.89		

$^{**}p<.01$.

TABLE 39. Analysis of variance relating to the skills in welding inspection

Variance	Source	df.	SS	MS	F	Prob>F
Skill121	Model	6	76.81	12.80	6.27^{**}	0.0001
	Error	256	523.01	2.04		
Skill122	Model	6	102.33	17.05	8.45^{**}	0.0001
	Error	256	516.88	2.02		
Skill123	Model	6	113.27	18.88	9.58^{**}	0.0001
	Error	256	504.34	1.97		
Skill124	Model	6	62.09	10.35	5.42^{**}	0.0001
	Error	256	488.65	1.91		

$^{**}p<.01$.

TABLE 40. Analysis of variance relating to the skills in numerical control working

Variance	Source	df.	SS	MS	F	Prob>F
Skill131	Model	6	82.42	13.74	5.96^{**}	0.0001
	Error	256	589.56	2.30		
Skill132	Model	6	69.86	11.64	4.71^{**}	0.0001
	Error	256	632.79	2.47		

$^{**}p<.01$.

TABLE 41. Analysis of variance relating to the skill difficulties among skilled workers, supervisors, and teachers

Variance	Source	df.	SS	MS	F	Prob>F
Skill 1	Model	2	40.75	20.73	21.93**	0.0001
	Error	260	241.75	0.93		
Skill 2	Model	2	87.09	43.54	26.45**	0.0001
	Error	260	428.03	1.65		
Skill 3	Model	2	105.85	52.93	33.36**	0.0001
	Error	260	412.49	1.59		
Skill 4	Model	2	18.06	9.03	8.06**	0.0004
	Error	260	291.33	1.12		
Skill 5	Model	2	19.68	9.84	10.03**	0.0001
	Error	260	255.15	0.98		
Skill 6	Model	2	88.46	44.23	39.53**	0.0001
	Error	260	290.93	1.12		
Skill 7	Model	2	98.42	49.21	21.83**	0.0001
	Error	260	586.26	2.25		
Skill 8	Model	2	40.36	20.18	14.53**	0.0001
	Error	260	261.11	1.39		
Skill 9	Model	2	125.45	62.73	39.93**	0.0001
	Error	260	408.49	1.57		
Skill 10	Model	2	27.67	13.84	8.86**	0.0002
	Error	260	406.09	1.56		
Skill 11	Model	2	31.61	15.80	11.30**	0.0001
	Error	260	363.64	1.40		
Skill 12	Model	2	53.70	26.85	16.02**	0.0001
	Error	260	435.90	1.68		
Skill 13	Model	2	55.42	27.71	12.89**	0.0001
	Error	260	558.90	2.15		

**$p<.01$.

TABLE 42. Analysis of variance relating to the knowledge requirements among skilled workers, supervisors, and teachers

Variance	Source	df.	SS	MS	F	Prob>F
Know. 1	Model	2	55.09	27.54	29.5**	0.0001
	Error	260	243.11	0.93		
Know. 2	Model	2	35.97	17.99	13.8**	0.0001
	Error	260	339.81	1.31		
Know. 3	Model	2	80.81	40.40	31.90**	0.0001
	Error	260	329.40	1.27		
Know. 4	Model	2	56.53	28.26	24.9**	0.0004
	Error	260	295.01	1.14		
Know. 5	Model	2	57.49	28.75	21.0**	0.0001
	Error	260	355.80	1.37		
Know. 6	Model	2	72.50	36.25	33.6**	0.0001
	Error	260	280.29	1.07		
Know. 7	Model	2	107.59	53.79	42.3**	0.0001
	Error	260	330.45	1.27		
Know. 8	Model	2	67.05	33.52	25.6**	0.0001
	Error	260	340.58	1.31		
Know. 9	Model	2	76.82	38.41	22.9**	0.0001
	Error	260	435.37	1.68		
Know. 10	Model	2	55.01	27.50	18.9**	0.0001
	Error	260	377.57	1.45		

**$p<.01$.

APPENDIX C. SCHEFFÉ'S MULTIPLE RANGE TESTS

TABLE 43. Scheffé's Multiple Range Comparison of the skill in general forming of light gage sheet metal

	Means	Ocp.1 2.81	Ocp.2 2.65	Ocp.3 2.32	Ocp.4 2.21	Ocp.5 2.02	Ocp.6 2.87
Ocp.1	2.81	--					
Ocp.2	2.65	0.16	--				
Ocp.3	2.32	0.49	0.33	--			
Ocp.4	2.21	0.60	0.44	0.10	--		
Ocp.5	2.02	0.79*	0.63	0.29	0.19	--	
Ocp.6	2.87	-0.06	-0.22	-0.55	-0.65	-0.84	--

In this, and subsequent tables:

Ocp.1: General sheet metal occupation
Ocp.2: Auto body sheet metal occupation
Ocp.3: Sheet metal plastic forming occupation
Ocp.4: Platemetal cold working occupation
Ocp.5: Welding working occupation
Ocp.6: Piping or plumbing occupation

*$p<.05$.

TABLE 44. Scheffé's Multiple Range Comparison of the skill in auto body working

	Means	Ocp.1 1.91	Ocp.2 3.74	Ocp.3 1.85	Ocp.4 1.92	Ocp.5 2.04	Ocp.6 3.75
Ocp.1	1.91	--					
Ocp.2	3.74	-1.82**	--				
Ocp.3	1.85	-0.06	1.88**	--			
Ocp.4	1.92	-0.01	1.81**	-0.07	--		
Ocp.5	2.04	-0.12	1.70**	-0.18	-0.11	--	
Ocp.6	3.75	-1.84	-0.01	-1.90	-1.83	-1.71	--

**$p<.01$.

TABLE 45. Scheffé's Multiple Range Comparison of the skill in arc welding

	Means	Ocp.1 3.21	Ocp.2 2.98	Ocp.3 2.32	Ocp.4 3.35	Ocp.5 3.58	Ocp.6 2.63
Ocp.1	3.21	--					
Ocp.2	2.98	0.23	--				
Ocp.3	2.32	0.38	0.65	--			
Ocp.4	3.35	-0.14	-0.37	-1.03	--		
Ocp.5	3.58	-0.38	-0.61	-1.26*	-0.23	--	
Ocp.6	2.63	0.58	0.35	-0.31	0.72	0.95	--

*$p<.05$.

TABLE 46. Scheffé's Multiple Range Comparison of the skill in resistance welding

	Means	Ocp.1 3.55	Ocp.2 3.40	Ocp.3 2.50	Ocp.4 1.89	Ocp.5 2.15	Ocp.6 4.00
Ocp.1	3.55	--					
Ocp.2	3.40	0.15	--				
Ocp.3	2,50	1.05	0.90	--			
Ocp.4	1.89	1.40**	1.50**	0.60	--		
Ocp.5	2.15	1.65**	1.25	0.35	-0.25	--	
Ocp.6	4.00	-0.45	-0.60	-1.50	-2.10	-1.85	--

**p<.01.

TABLE 47. Scheffé's Multiple Range Comparison of the skill in sheet-metal press working

	Means	Ocp.1 2.96	Ocp.2 2.96	Ocp.3 2.61	Ocp.4 2.26	Ocp.5 1.85	Ocp.6 3.00
Ocp.1	2.96	--					
Ocp.2	2.96	0.00	--				
Ocp.3	2.61	0.35	0.35	--			
Ocp.4	2.26	0.70	0.70	0.35	--		
Ocp.5	1.85	1.11**	1.11**	0.76	0.41	--	
Ocp.6	3.00	-0.04	-0.04	-0.39	-0.74	-1.15	--

**p<.01.

TABLE 48. Scheffé's Multiple Range Comparison of the skill in cold metal working

	Means	Ocp.1 2.43	Ocp.2 2.85	Ocp.3 1.83	Ocp.4 3.67	Ocp.5 2.77	Ocp.6 2.83
Ocp.1	2/43	--					
Ocp.2	2.85	-0.42	--				
Ocp.3	1.83	0.60	1.02	--			
Ocp.4	3.67	-1.24**	-0.82	-1.84**	--		
Ocp.5	2.77	-0.34	0.08	-0.94	-0.90	--	
Ocp.6	2.83	-0.40	0.02	-1.00	-0.84	-0.06	--

**$p<.01$.

TABLE 49. Scheffé's Multiple Range Comparison of the skill in sheet metal rolling

	M	Tr. 3.84	O.1 2.72	O.2 2.60	O.3 2.08	O.4 2.52	O.5 1.96	O.6 3.33
Tr.	3.84	--						
O.1	2.72	1.12*	--					
O.2	2.60	1.24*	0.12	--				
O.3	2.08	1.75*	0.63	0.52	--			
O.4	2.52	1.32*	0.20	0.08	0.43	--		
O.5	1.96	1.87*	0.75	0.64	0.12	0.55	--	
O.6	3.33	0.51	0.62	0.73	1.25	0.81	1.37	--

In this, and all subsequent tables:

Tr.: Teachers
O.1: General sheet metal working occupation
O.2: Auto body sheet metal working occupation
O.3: Sheet metal plastic forming occupation
O.4: Platemetal cold working occupation
O.5: Welding working occupation
O.6: Piping or plumbing occupation

*$p<.05$.

TABLE 50. Scheffé's Multiple Range Comparison of the skill in sheet metal bending

	M	Tr. 4.12	0.1 3.94	0.2 3.20	0.3 2.75	0.4 2.82	0.5 2.22	0.6 3.33
Tr.	4.12	--						
0.1	3.94	0.17	--					
0.2	3.20	0.92	0.74	--				
0.3	2.75	1.36	1.19	0.45	--			
0.4	2.82	1.29*	1.11*	0.37	0.08	--		
0.5	2.22	1.89*	1.72*	0.98	0.53	0.61	--	
0.6	3.33	0.78	0.61	0.13	0.58	0.51	1.11	--

*$p<.05$.

TABLE 51. Scheffé's Multiple Range Comparison of the skill in sheet metal seam working

	M	Tr. 3.53	0.1 2.58	0.2 2.97	0.3 2.33	0.4 1.97	0.5 2.37	0.6 3.00
Tr.	3.53	--						
0.1	2.58	0.96*	--					
0.2	2.97	0.56	0.39	--				
0.3	2.33	1.20	0.25	0.64	--			
0.4	1.97	1.57*	0.61	1.01	0.37	--		
0.5	2.37	1.17	0.21	0.60	0.04	0.40	--	
0.6	3.00	0.54	0.42	0.03	0.67	1.03	0.63	--

*$p<.05$.

TABLE 52. Scheffé's Multiple Range Comparison of the skill in rivet working

	M	Tr. 2.73	0.1 1.89	0.2 2.11	0.3 2.25	0.4 1.62	0.5 1.63	0.6 1.67
Tr.	2.73	--						
0.1	1.89	0.85*	--					
0.2	2.11	0.62	0.23	--				
0.3	2.25	0.49	0.36	0.14	--			
0.4	1.62	1.12*	0.27	0.49	0.14	--		
0.5	1.63	1.11*	0.26	0.48	0.62	0.01	--	
0.6	1.67	1.07	0.22	0.45	0.58	0.05	0.04	--

*$p<.05$.

TABLE 53. Scheffé's Multiple Range Comparison of the skill in parallel line development

	M	Tr. 4.38	0.1 3.50	0.2 3.06	0.3 2.58	0.4 3.14	0.5 2.07	0.6 4.33
Tr.	4.38	--						
0.1	3.50	0.88*	--					
0.2	3.06	1.32*	0.44	--				
0.3	2.58	1.79*	0.92	0.47	--			
0.4	3.14	1.24*	0.36	0.08	0.55	--		
0.5	2.07	2.03*	1.43	0.98	0.51	1.06	--	
0.6	4.33	0.04	0.83	1.28	1.75	1.20	2.26	--

*$p<.05$.

TABLE 54. Scheffé's Multiple Range Comparison of the skill in radial line development

	M	Tr. 3.96	0.1 2.59	0.2 3.06	0.3 2.17	0.4 2.76	0.5 2.00	0.6 4.00
Tr.	3.96	--						
0.1	2.59	1.37*	--					
0.2	3.06	0.90	0.47	--				
0.3	2.17	1.79*	0.42	0.89	--			
0.4	2.76	1.20*	0.17	0.30	0.59	--		
0.5	2.00	1.96*	0.59	1.06	0.17	0.76	--	
0.6	4.00	0.04	1.41	0.94	1.83	1.24	2.00	--

*$p<.05$.

TABLE 55. Scheffé's Multiple Range Comparison of the skill in triangulation development

	M	Tr. 3.68	0.1 2.68	0.2 2.83	0.3 1.92	0.4 2.76	0.5 2.15	0.6 3.33
Tr.	3.68	--						
0.1	2.68	1.00*	--					
0.2	2.83	0.85	0.15	--				
0.3	1.92	1.76*	0.77	0.91	--			
0.4	2.76	0.92	0.08	0.07	0.84	--		
0.5	2.15	1.53*	0.53	0.68	0.23	0.61	--	
0.6	3.33	0.35	0.65	0.50	1.42	0.57	1.19--	

*$p<.05$.

TABLE 56. Scheffé's Multiple Range Comparison of the skill in basic sheet metal stretching and compression wrinkling

	M	Tr. 4.12	0.1 2.02	0.2 3.83	0.3 1.92	0.4 1.97	0.5 2.00	0.6 4.00
Tr.	4.12	--						
0.1	2.02	0.09*	--					
0.2	3.83	0.29	1.81*	--				
0.3	1.92	2.20*	0.11	1.91*	--			
0.4	1.97	2.15*	0.06	1.86*	0.05	--		
0.5	2.00	2.12*	0.02	1.83*	0.08	0.03	--	
0.6	4.00	0.12	1.98	0.17	2.08	2.03	2.00	--

*$p<.05$.

TABLE 57. Scheffé's Multiple Range Comparison of the skill in advanced sheet-metal stretching and compression wrinkling

	M	Tr. 3.06	0.1 1.77	0.2 3.00	0.3 1.67	0.4 2.10	0.5 1.74	0.6 3.33
Tr.	3.06	--						
0.1	1.77	1.29*	--					
0.2	3.00	0.06	1.23*	--				
0.3	1.67	1.39	0.11	1.33	--			
0.4	2.10	0.95	0.33	0.90	0.44	--		
0.5	1.74	1.32*	0.03	1.26*	0.07	0.36	--	
0.6	3.33	0.28	1.56	0.33	1.67	1.23	1.59	--

*$p<.05$.

TABLE 58. Scheffé's Multiple Range Comparison of the skill in panel replacement

	M	Tr. 3.78	0.1 1.84	0.2 4.06	0.3 2.00	0.4 1.72	0.5 2.14	0.6 4.33
Tr.	3.78	--						
0.1	1.84	1.94*	--					
0.2	4.06	0.27	2.22*	--				
0.3	2.00	1.78*	0.16	2.06*	--			
0.4	1.72	2.06*	0.12	2.33*	0.28	--		
0.5	2.14	1.63*	0.31	1.91*	0.15	0.42	--	
0.6	4.33	0.55	2.50	0.28	2.33	2.61	2.19--	

*$p<.05$.

TABLE 59. Scheffé's Multiple Range Comparison of the skill in corrosion protection and painting

	M	Tr. 3.94	0.1 2.02	0.2 4.06	0.3 1.83	0.4 1.90	0.5 2.26	0.6 3.33
Tr.	3.94	--						
0.1	2.02	1.92*	--					
0.2	4.06	0.12	2.03*	--				
0.3	1.83	2.11*	0.19	2.22*	--			
0.4	1.90	2.05*	0.13	2.16*	0.06	--		
0.5	2.26	1.68*	0.24	1.80*	0.43	0.36	--	
0.6	3.33	0.61	1.31	0.72	1.50	1.44	1.07	--

*p<.05.

TABLE 60. Scheffé's Multiple Range Comparison of the skill in thin plate butt gas welding

	M	Tr. 4.28	0.1 3.02	0.2 3.49	0.3 2.17	0.4 1.90	0.5 2.59	0.6 4.00
Tr.	4.28	--						
0.1	3.02	1.25*	--					
0.2	3.49	0.79	0.46	--				
0.3	2.17	2.11*	0.86	1.32	--			
0.4	1.90	2.38*	1.13*	1.59*	0.27	--		
0.5	2.59	1.68*	0.43	0.89	0.43	0.70	--	
0.6	4.00	0.28	0.98	0.51	1.83	2.10	1.41	--

*p<.05.

TABLE 61. Scheffé's Multiple Range Comparison of the skill in thin plate lap gas welding

	M	Tr. 3.35	0.1 2.44	0.2 3.00	0.3 2.17	0.4 1.83	0.5 2.52	0.6 3.67
Tr.	3.35	--						
0.1	2.44	0.35*	--					
0.2	3.00	0.35	0.56	--				
0.3	2.17	1.18	0.28	0.83	--			
0.4	1.83	1.52*	0.62	1.17	0.34	--		
0.5	2.52	0.83	0.08	0.48	0.35	0.69	--	
0.6	3.67	0.32	1.22	0.67	1.50	1.84	1.87	--

*$p<.05$.

TABLE 62. Scheffé's Multiple Range Comparison of the skill in gas cutting

	M	Tr. 4.32	0.1 3.70	0.2 3.71	0.3 2.66	0.4 3.83	0.5 4.11	0.6 3.33
Tr.	4.32	--						
0.1	3.70	0.61	--					
0.2	3.71	0.60	0.01	--				
0.3	2.66	1.65*	1.04	1.05	--			
0.4	3.83	0.49	0.12	0.11	1.16	--		
0.5	4.11	0.21	0.41	0.40	1.44	0.28	--	
0.6	3.33	0.99	0.37	0.38	0.67	0.49	0.78	--

*$p<.05$.

TABLE 63. Scheffe's Multiple Range Comparison of the skill in flat position arc welding

	M	Tr. 4.57	0.1 4.26	0.2 3.77	0.3 2.42	0.4 4.07	0.5 4.60	0.6 3.00
Tr.	4.57	--						
0.1	4.26	0.37	--					
0.2	3.77	0.07	0.49	--				
0.3	2.42	0.84*	1.84*	1.35	--			
0.4	4.07	0.43	0.19	0.30	1.65*	--		
0.5	4.60	0.98	0.33	0.82	2.18*	0.52	--	
0.6	3.00	0.90	1.26	0.77	0.58	1.07	1.60	--

*$p<.05$.

TABLE 64. Scheffe's Multiple Range Comparison of the skill in horizontal position arc welding

	M	Tr. 3.88	0.1 3.56	0.2 3.31	0.3 2.25	0.4 3.38	0.5 3.70	0.6 2.66
Tr.	3.88	--						
0.1	3.56	0.33	--					
0.2	3.31	0.60	0.24	--				
0.3	2.25	1.63*	1.31	1.06	--			
0.4	3.38	0.50	0.18	0.07	1.12	--		
0.5	3.70	0.18	0.15	0.39	1.45	0.32	--	
0.6	2.66	1.22	0.89	0.65	0.42	0.71	1.04	--

*$p<.05$.

TABLE 65. Scheffé's Multiple Range Comparison of the skill in vertical position arc welding

	M	Tr. 3.72	O.1 3.41	O.2 2.86	O.3 2.00	O.4 3.38	O.5 3.89	O.6 2.67
Tr.	3.72	--						
O.1	3.41	0.32	--					
O.2	2.86	0.87	0.55	--				
O.3	2.00	1.72*	1.41	0.86	--			
O.4	3.38	0.35	0.03	0.52	1.38	--		
O.5	3.89	0.16	0.48	1.03	1.89*	0.51	--	
O.6	2.67	1.06	0.74	0.19	0.67	0.71	1.22	--

*p<.05.

TABLE 66. Scheffé's Multiple Range Comparison of the skill in corner joint arc welding

	M	Tr. 4.10	O.1 3.52	O.2 3.03	O.3 2.25	O.4 3.62	O.5 4.19	O.6 2.33
Tr.	4.10	--						
O.1	3.52	0.58	--					
O.2	3.03	1.07*	0.49	--				
O.3	2.25	1.85*	1.27	0.78	--			
O.4	3.62	0.48	0.10	0.59	1.37	--		
O.5	4.19	0.08	0.66	1.16	1.93*	0.56	--	
O.6	2.33	1.77	1.19	0.70	0.08	1.29	1.85	--

*p<.05.

TABLE 67. Scheffé's Multiple Range Comparison of the skill in gas tungsten arc welding

	M	Tr. 4.22	0.1 3.11	0.2 2.89	0.3 2.67	0.4 3.59	0.5 3.44	0.6 3.33
Tr.	4.22	--						
0.1	3.11	1.10*	--					
0.2	2.89	1.33*	0.23	--				
0.3	2.67	1.55	0.45	0.22	--			
0.4	3.59	0.98	0.13	0.36	0.57	--		
0.5	3.44	0.77	0.33	0.56	0.78	0.20	--	
0.6	3.33	0.88	0.22	0.45	0.67	0.09	0.11	--

*$p<.05$.

TABLE 68. Scheffé's Multiple Range Comparison of the skill in pipe welding

	M	Tr. 3.46	0.1 2.59	0.2 2.83	0.3 2.08	0.4 2.59	0.5 4.00	0.6 2.00
Tr.	3.46	--						
0.1	2.59	0.87*	--					
0.2	2.83	0.64	0.24	--				
0.3	2.08	1.38	0.51	0.75	--			
0.4	2.59	0.12	1.00	0.76	1.50	--		
0.5	4.00	0.54	1.41*	1.17	1.92*	0.41	--	
0.6	2.00	1.46	0.59	0.83	0.08	1.59	2.00	--

*$p<.05$.

TABLE 69. Scheffé's Multiple Range Comparison of the skill in submerged arc welding

	M	Tr. 2.93	0.1 1.92	0.2 2.17	0.3 2.33	0.4 3.62	0.5 2.18	0.6 2.33
Tr.	2.93	--						
0.1	1.92	1.01*	--					
0.2	2.17	0.72	0.25	--				
0.3	2.33	0.59	0.41	0.16	--			
0.4	3.26	0.17	0.84	0.59	0.43	--		
0.5	2.18	0.74	0.26	0.01	0.15	0.57	--	
0.6	2.33	0.59	0.41	0.16	0.00	0.43	0.15	--

*$p<.05$.

TABLE 70. Scheffé's Multiple Range Comparison of the skill in bending of pressworking

	M	Tr. 4.19	0.1 3.77	0.2 3.06	0.3 2.42	0.4 2.65	0.5 2.00	0.6 3.00
Tr.	4.19	--						
0.1	3.77	0.42	--					
0.2	3.06	1.13*	0.72	--				
0.3	2.42	1.77*	1.36	0.64	--			
0.4	2.65	1.53*	1.12*	0.40	0.24	--		
0.5	2.00	2.19*	1.77*	1.06	0.42	0.66	--	
0.6	3.00	1.19	0.77	0.06	0.58	0.34	1.00	--

*$p<.05$.

TABLE 71. Scheffé's Multiple Range Comparison of the skill in drawing of pressworking

	M	Tr. 3.63	O.1 3.17	O.2 3.25	O.3 2.83	O.4 2.21	O.5 1.89	O.6 3.33
Tr.	3.63	--						
O.1	3.17	0.47	--					
O.2	3.25	0.38	0.09	--				
O.3	2.83	0.80	0.34	0.42	--			
O.4	2.21	1.43*	0.96*	1.05	0.63	--		
O.5	1.89	1.75*	1.28	1.37*	0.94	0.32	--	
O.6	3.33	0.30	0.16	0.08	0.50	1.13	1.44	--

*p<.05.

TABLE 72. Scheffé's Multiple Range Comparison of the skill in heavy gage metal layout and cutting

	M	Tr. 3.84	O.1 2.70	O.2 2.89	O.3 2.00	O.4 3.97	O.5 3.30	O.6 3.00
Tr.	3.84	--						
O.1	2.70	0.14*	--					
O.2	2.89	0.95	0.18	--				
O.3	2.00	1.84*	0.70	0.89	--			
O.4	3.97	0.12	1.26*	1.08	1.97*	--		
O.5	3.30	0.54	0.59	0.41	1.30	0.67	--	
O.6	3.00	0.84	0.30	0.11	1.00	0.97	0.30	--

*p<.05.

TABLE 73. Scheffé's Multiple Range Comparison of the skill in heavy gage metal forming

	M	Tr. 3.65	0.1 2.49	0.2 3.22	0.3 1.92	0.4 4.03	0.5 2.78	0.6 3.00
Tr.	3.65	--						
0.1	2.49	1.16*	--					
0.2	3.22	0.42	0.74	--				
0.3	1.92	1.74*	0.57	1.31	--			
0.4	4.03	0.38	1.55*	0.81	2.12*	--		
0.5	2.78	0.87	0.29	0.45	0.86	1.26	--	
0.6	3.00	0.65	0.51	0.23	1.08	1.03	0.22	--

*$p<.05$.

TABLE 74. Scheffé's Multiple Range Comparison of the skill in construction working

	M	Tr. 3.26	0.1 2.40	0.2 3.03	0.3 1.58	0.4 3.41	0.5 2.74	0.6 3.00
Tr.	3.26	--						
0.1	2.40	0.86*	--					
0.2	3.03	0.23	0.63	--				
0.3	1.58	1.68*	0.81	1.45	--			
0.4	3.41	0.15	1.02	0.39	1.83*	--		
0.5	2.74	0.52	0.34	0.29	1.16	0.67	--	
0.6	3.00	0.26	0.60	0.03	1.42	0.41	0.26	--

*$p<.05$.

TABLE 75. Scheffé's Multiple Range Comparison of the skill in heavy gage metal complex layout and forming

	M	Tr. 2.91	0.1 2.13	0.2 2.26	0.3 1.83	0.4 3.28	0.5 2.26	0.6 2.33
Tr.	2.91	--						
0.1	2.13	0.78	--					
0.2	2.26	0.66	0.12	--				
0.3	1.83	1.08	0.30	0.42	--			
0.4	3.28	0.36	1.14*	1.02	1.44	--		
0.5	2.26	0.65	0.12	0.00	0.43	1.02	--	
0.6	2.33	0.58	0.20	0.08	0.50	0.94	0.07	--

*$p<.05$.

TABLE 76. Scheffé's Multiple Range Comparison of the skill in destructive welding inspection

	M	Tr. 3.16	0.1 1.90	0.2 2.40	0.3 1.42	0.4 2.41	0.5 2.56	0.6 3.33
Tr.	3.16	--						
0.1	1.90	1.26*	--					
0.2	2.40	0.76	0.50	--				
0.3	1.42	1.74*	0.48	0.98	--			
0.4	2.41	0.75	0.51	0.01	1.00	--		
0.5	2.56	0.60	0.66	0.16	1.14	0.14	--	
0.6	3.33	0.17	1.44	0.93	1.92	0.92	0.78	--

*$p<.05$.

TABLE 77. Scheffé's Multiple Range Comparison of the skill in welding X-ray inspection

	M	Tr. 3.04	0.1 1.59	0.2 2.14	0.3 1.08	0.4 2.52	0.5 2.37	0.6 3.00
Tr.	3.04	--						
0.1	1.59	1.45*	--					
0.2	2.14	0.90	0.55	--				
0.3	1.08	1.96*	0.51	1.06	--			
0.4	2.52	0.53	0.93	0.37	1.43	--		
0.5	2.37	0.67	0.78	0.23	1.29	0.15	--	
0.6	3.00	0.04	1.41	0.86	1.92	0.48	0.63	--

*$p<.05$.

TABLE 78. Scheffé's Multiple Range Comparison of the skill in welding ultrasonic wave inspection

	M	Tr. 3.14	0.1 1.60	0.2 2.34	0.3 1.08	0.4 2.52	0.5 2.44	0.6 3.00
Tr.	3.14	--						
0.1	1.60	1.54*	--					
0.2	2.34	0.80	0.74	--				
0.3	1.08	2.06*	0.52	1.26	--			
0.4	2.52	0.63	0.92	0.17	1.43	--		
0.5	2.44	0.70	0.84	0.10	1.36	0.07	--	
0.6	3.00	0.15	1.40	0.66	1.92	0.48	0.56	--

*$p<.05$.

TABLE 79. Scheffé's Multiple Range Comparison of the skill in other pipe inspections

	M	Tr. 2.86	O.1 1.73	O.2 2.34	O.3 1.66	O.4 2.79	O.5 2.22	O.6 2.33
Tr.	2.86	--						
O.1	1.73	1.13*	--					
O.2	2.34	0.51	0.62	--				
O.3	1.66	1.19	0.06	0.68	--			
O.4	2.79	0.06	1.07*	0.45	1.13	--		
O.5	2.22	0.63	0.49	0.12	0.56	0.57	--	
O.6	2.33	0.52	0.61	0.01	0.67	0.46	0.11	--

*$p<.05$.

TABLE 80. Scheffé's Multiple Range Comparison of the skill in softwave working of numerical control machine

	M	Tr. 3.39	O.1 2.49	O.2 2.57	O.3 2.75	O.4 1.72	O.5 1.93	O.6 3.67
Tr.	3.39	--						
O.1	2.49	0.90*	--					
O.2	2.57	0.82	0.08	--				
O.3	2.75	0.64	0.26	0.18	--			
O.4	1.72	1.67*	0.76	0.85	1.03	--		
O.5	1.93	1.47*	0.56	0.65	0.82	0.20	--	
O.6	3.67	0.28	1.18	1.10	0.92	1.94	1.74	--

*$p<.05$.

TABLE 81. Scheffé's Multiple Range Comparison of the skill in setup and operation of numerical control machine

	M	Tr. 3.46	O.1 2.78	O.2 2.69	O.3 2.50	O.4 1.86	O.5 2.19	O.6 3.67
Tr.	3.46	--						
O.1	2.78	0.68	--					
O.2	2.69	0.78	0.10	--				
O.3	2.50	0.96	0.28	0.19	--			
O.4	1.86	1.60*	0.92	0.82	0.64	--		
O.5	2.19	1.28*	0.60	0.50	0.31	0.32	--	
O.6	3.67	0.20	0.88	0.98	1.17	1.80	1.48	--

*$p<.05$.

TABLE 82. Scheffé's Multiple Range Comparison of the skill in general forming (light gage) among skilled workers, supervisors, and teachers

	M	Spvsr. 2.65	SklWkr. 2.50	Tchrs. 3.43
Spvsr.	2.65	--		
SklWkr.	2.50	0.15	--	
Tchrs.	3.43	0.87*	0.93*	--

In this, and all subsequent tables:

Spvsr.: Supervisors
SklWkr.: Skilled workers
Tchrs.: Teachers

*$p<.05$.

TABLE 83. Scheffé's Multiple Range Comparison of the skill in development method among supervisors, skilled workers, and teachers

	M	Spvsr. 3.14	SklWkr. 2.62	Tchrs. 4.00
Spvsr.	3.14	--		
SklWkr.	2.62	0.52*	--	
Tchrs.	4.00	0.86*	1.38*	--

*$p<.05$.

TABLE 84. Scheffé's Multiple Range Comparison of the skill in auto body working among supervisors, skilled working, and teachers

	M	Spvsr. 2.21	SklWkr. 2.32	Tchrs. 3.72
Spvsr.	2.21	--		
SklWkr.	2.32	0.11	--	
Tchrs.	3.72	1.52*	1.40*	--

*p<.05.

TABLE 85. Scheffé's Multiple Range Comparison of the skill in gas welding and cutting among supervisors, skilled workers, and teachers

	M	Spvsr. 2.86	SklWkr. 2.78	Tchrs. 3.40
Spvsr.	2.86	--		
SklWkr.	2.78	0.80	--	
Tchrs.	3.40	0.53*	0.62*	--

*p<.05.

TABLE 86. Scheffé's Multiple Range Comparison of the skill in arc welding among supervisors, skilled workers, and teachers

	M	Spvsr. 3.28	SklWkr. 3.13	Tchrs. 3.78
Spvsr.	3.28	--		
SklWkr.	3.13	0.15	--	
Tchrs.	3.78	0.50*	0.65*	--

*p<.05.

TABLE 87. Scheffé's Multiple Range Comparison of the skill in soldering and brazing among supervisors, skilled workers, and teachers

	M	Spvsr. 2.21	SklWkr. 1.77	Tchrs. 3.16
Spvsr.	2.21	--		
SklWkr.	1.77	0.44	--	
Tchrs.	3.16	0.96*	1.39*	--

*p<.05.

TABLE 88. Scheffé's Multiple Range Comparison of the skill in resistance welding among supervisors, skilled workers, and teachers

	M	Spvsr. 3.41	SklWkr. 2.85	Tchrs. 4.32
Spvsr.	3.41	--		
SklWkr.	2.85	0.55	--	
Tchrs.	4.32	0.91*	1.47*	--

*p<.05.

TABLE 89. Scheffé's Multiple Range Comparison of the skill in sheet-metal pressworking among supervisors, skilled workers, and teachers

	M	Spvsr. 2.93	SklWkr. 2.57	Tchrs. 3.51
Spvsr.	2.93	--		
SklWkr.	2.57	0.36	--	
Tchrs.	3.51	0.85*	0.94*	--

*p<.05.

TABLE 90. Scheffé's Multiple Range Comparison of the skill in basic bench working among supervisors, skilled workers, and teachers

	M	Spvsr. 3.14	SklWkr. 2.42	Tchrs. 4.07
Spvsr.	3.14	--		
SklWkr.	2.42	0.71*	--	
Tchrs.	4.07	0.94*	1.65*	--

*p<.05.

TABLE 91. Scheffé's Multiple Range Comparison of the skill in cold metal working among supervisors, skilled workers, and teachers

	M	Spvsr. 2.87	SklWkr. 2.64	Tchrs. 3.42
Spvsr.	2.87	--		
SklWkr.	2.62	0.23	--	
Tchrs.	3.42	0.55*	0.78*	--

*p<.05.

TABLE 92. Scheffé's Multiple Range Comparison of the skill in plumbing and piping among supervisors, skilled workers, and teachers

	M	Spvsr. 2.17	SklWkr. 1.95	Tchrs. 2.78
Spvsr.	2.17	--		
SklWkr.	1.95	0.22	--	
Tchrs.	2.78	0.61*	0.83*	--

*p<.05.

TABLE 93. Scheffé's Multiple Range Comparison of the skill in welding inspection among supervisors, skilled workers, and teachers

	M	Spvsr. 2.14	SklWkr. 1.99	Tchrs. 3.05
Spvsr.	2.14	--		
SklWkr.	1.99	0.15	--	
Tchrs.	3.05	0.92*	1.06*	--

*p<.05.

TABLE 94. Scheffé's Multiple Range Comparison of the skill in numerical control working among supervisors, skilled workers, and teachers

	M	Spvsr. 2.71	SklWkr. 2.33	Tchrs. 3.43
Spvsr.	2.71	--		
SklWkr.	2.33	0.39	--	
Tchrs.	3.43	0.72*	1.10*	--

*p<.05.

TABLE 95. Scheffé's Multiple Range Tests of knowledge in mechanical materials among supervisors, skilled workers, and teachers

	M	Spvsr. 2.91	SklWkr. 2.49	Tchrs. 3.58
Spvsr.	2.91	--		
SklWkr.	2.49	0.42*	--	
Tchrs.	3.58	0.67*	1.09*	--

*p<.05.

TABLE 96. Scheffé's Multiple Range Tests of knowledge in welding technology among supervisors, skilled workers, and teachers

	M	Spvsr. 3.50	SklWkr. 3.18	Tchrs. 4.07
Spvsr.	3.50	--		
SklWkr.	3.18	0.32	--	
Tchrs.	4.07	0.56*	0.89*	--

*p<.05.

TABLE 97. Scheffé's Multiple Range Tests of knowledge in heat treatment among supervisors, skilled workers, and teachers

	M	Spvsr. 2.56	SklWkr. 2.24	Tchrs. 3.56
Spvsr.	2.56	--		
SklWkr.	2.24	0.32	--	
Tchrs.	3.56	1.00*	1.33*	--

*p<.05.

TABLE 98. Scheffé's Multiple Range Tests of knowledge in introduction of pressworking among supervisors, skilled workers, and teachers

	M	Spvsr. 3.07	SklWkr. 2.52	Tchrs. 3.63
Spvsr.	3.07	--		
SklWkr.	2.53	0.55*	--	
Tchrs.	3.63	0.55*	1.10*	--

*p<.05.

TABLE 99. Scheffé's Multiple Range Tests of knowledge in piping and plumbing among supervisors, skilled workers, and teachers

	M	Spvsr. 2.25	SklWkr. 2.16	Tchrs. 3.37
Spvsr.	2.25	--		
SklWkr.	2.16	0.09	--	
Tchrs.	3.37	1.10*	1.09*	--

*p<.05.

TABLE 100. Scheffé's Multiple Range Tests of knowledge in sheet metal plastic forming among supervisors, skilled workers, and teachers

	M	Spvsr. 2.23	SklWkr. 1.98	Tchrs. 3.23
Spvsr.	2.23	--		
SklWkr.	1.98	0.24	--	
Tchrs.	3.23	1.00*	1.25*	--

*p<.05.

TABLE 101. Scheffé's Multiple Range Tests of knowledge in mechanic among supervisors, skilled workers, and teachers

	M	Spvsr. 2.65	SklWkr. 2.23	Tchrs. 3.76
Spvsr.	2.65	--		
SklWkr.	2.23	0.15	--	
Tchrs.	3.76	1.11*	1.53*	--

*p<.05.

TABLE 102. Scheffé's Multiple Range Tests of knowledge in material mechanics among supervisors, skilled workers, and teachers

	M	Spvsr. 2.74	SklWkr. 2.33	Tchrs. 3.54
Spvsr.	2.74	--		
SklWkr.	2.33	0.41	--	
Tchrs.	3.54	0.80*	1.21*	--

*$p<.05$.

TABLE 103. Scheffé's Multiple Range Tests of knowledge in numerical control among supervisors, skilled workers, and teachers

	M	Spvsr. 3.05	SklWkr. 2.49	Tchrs. 3.78
Spvsr.	3.05	--		
SklWkr.	2.49	0.56*	--	
Tchrs.	3.78	0.73*	1.29*	--

*$p<.05$.

TABLE 104. Scheffé's Multiple Range Tests of knowledge in air conditioning among supervisors, skilled workers, and teachers

	M	Spvsr. 2.37	SklWkr. 2.24	Tchrs. 3.31
Spvsr.	2.37	--		
SklWkr.	2.24	0.14	--	
Tchrs.	3.31	0.94*	1.07*	--

*$p<.05$.

APPENDIX D. PEARSON CORRELATION COEFFICIENTS

TABLE 105. Pearson correlation coefficients among skills for general sheet metal occupation

	SK1	SK2	SK3	SK4	SK5	SK6	SK7	SK8	SK9	SK10	SK11	SK12	SK13
SK1	1.0												
SK2	.66**	1.0											
SK3	.30*	.22*	1.0										
SK4	.16	.26*	.26*	1.0									
SK5	.14	.20	.26*	.54**	1.0								
SK6	.37**	.38**	.49**	.34**	.26*	1.0							
SK7	.22	.19	.15	.18	.28	.28	1.0						
SK8	.22	.17	.18	.33**	.48**	.29**	.27*	1.0					
SK9	.28*	.30**	.30**	.31**	.31**	.44**	.33**	.29*	1.0				
SK10	.29*	.33**	.25*	.58**	.58**	.33**	.19	.31**	.29*	1.0			
SK11	.28*	.38**	.41**	.27**	.34**	.53**	.10	.15	.33**	.44**	1.0		
SK12	.15	.28*	.51**	.25*	.27*	.53**	.13	.15	.41**	.44**	.78**	1.0	
SK13	.12	.12	.21	.21	.38**	.15	.18	.45**	.32**	.24*	.28*	.29*	1.0

Sk1: General forming (light gage)
Sk2: Development method
Sk3: Auto body working
Sk4: Gas welding
Sk5: Arc welding
Sk6: Soldering and brazing
Sk7: Resistance welding
Sk8: Sheet-metal pressworking
Sk9: Basic bench working
Sk10: Cold metal working
Sk11: Pluming and piping
Sk12: Welding inspection
Sk13: Numerical control working

TABLE 106. Pearson correlation coefficients among skills for auto body sheet metal working occupation

	SK1	SK2	SK3	SK4	SK5	SK6	SK7	SK8	SK9	SK10	SK11	SK12	SK13
SK1	1.0												
SK2	.56**	1.0											
SK3	.21	.12	1.0										
SK4	.48**	.32	.54**	1.0									
SK5	.53**	.64**	.36	.60**	1.0								
SK6	-.01	0.11	0.25	0.33	0.29	1.0							
SK7	.01	.12	-.02	.26	.15	.22	1.0						
SK8	.51**	.46**	.14	.38	.67**	.20	.39*	1.0					
SK9	.18	-.19	.39*	.14	.02	-.09	-.09	-.08	1.0				
SK10	.55**	.52**	.25	.34	.80**	.13	.03	.78**	.18	1.0			
SK11	.50**	.35	.34	.39*	.57**	.32	-.15	.48**	.20	.61**	1.0		
SK12	.44**	.29	.03	.41**	.44**	.11	-.04	.50**	.09	.51**	.63*	1.0	
SK13	.27	.24	.07	.36	.44	.14	.00	.51	.05	.51	.70	.65	1.0

Sk1: General forming (light gage)
Sk2: Development method
Sk3: Auto body working
Sk4: Gas welding
Sk5: Arc welding
Sk6: Soldering and brazing
Sk7: Resistance welding
Sk8: Sheet-metal pressworking
Sk9: Basic bench working
Sk10: Cold metal working
Sk11: Pluming and piping
Sk12: Welding inspection
Sk13: Numerical control working

TABLE 107. Pearson correlation coefficients among skills for plastic sheet metal forming occupation

	SK1	SK2	SK3	SK4	SK5	SK6	SK7	SK8	SK9	SK10	SK11	SK12	SK13
SK1	1.0												
SK2	.31	1.0											
SK3	.77**	.26	1.0										
SK4	.75**	.34	.95**	1.0									
SK5	.22	.00	.50	.41	1.0								
SK6	.46	.54	.51	.48	.39	1.0							
SK7	.45	.42	.70*	.53	.37	.66*	1.0						
SK8	.11	.14	.37	.29	.17	.31	.51	1.0					
SK9	-.20	.17	.01	-.09	-.03	.16	.50	.35	1.0				
SK10	.72*	.40	.91**	.91**	.38	.62	.66*	.12	-.08	1.0			
SK11	.64*	.04	.84**	.79**	.47	.19	.57	.43	.11	.63	1.0		
SK12	.66*	.04	.78**	.76**	.34	.29	.56	.27	.18	.67*	.89**	1.0	
SK13	.18	-.18	.39	.41	-.12	-.04	.27	.55	.17	.27	.41	.45	1.0

Sk1: General forming (light gage)
Sk2: Development method
Sk3: Auto body working
Sk4: Gas welding
Sk5: Arc welding
Sk6: Soldering and brazing
Sk7: Resistance welding
Sk8: Sheet-metal pressworking
Sk9: Basic bench working
Sk10: Cold metal working
Sk11: Pluming and piping
Sk12: Welding inspection
Sk13: Numerical control working

TABLE 108. Pearson correlation coefficients among skills for platemetal cold working occupation

	SK1	SK2	SK3	SK4	SK5	SK6	SK7	SK8	SK9	SK10	SK11	SK12	SK13
SK1	1.0												
SK2	.31	1.0											
SK3	.42*	.59**	1.0										
SK4	.41	.46*	.41	1.0									
SK5	.18	.17	.06	.32	1.0								
SK6	.31	.52**	.49*	.43*	.13	1.0							
SK7	.35	-.11	.25	-.11	-.01	.24	1.0						
SK8	.41	-.07	.30	.14	.23	.38	.61**	1.0					
SK9	.32	.49*	.31	.26	.35	.35	.08	.26	1.0				
SK10	.25	.06	-.08	.07	.67**	.08	-.02	.44**	.44**	1.0			
SK11	-.09	.37	.44*	.11	.19	.54**	.12	.09	.23	.01	1.0		
SK12	.04	.21	.17	.09	.63**	.28	.03	.24	.37	.39	.36	1.0	
SK13	.20	.22	.33	-.03	-.18	.48*	.36	.41	.25	.02	.23	.12	1.0

Sk1: General forming (light gage)
Sk2: Development method
Sk3: Auto body working
Sk4: Gas welding
Sk5: Arc welding
Sk6: Soldering and brazing
Sk7: Resistance welding
Sk8: Sheet-metal pressworking
Sk9: Basic bench working
Sk10: Cold metal working
Sk11: Pluming and piping
Sk12: Welding inspection
Sk13: Numerical control working

TABLE 109. Pearson correlation coefficients among skills for welding occupation

	SK1	SK2	SK3	SK4	SK5	SK6	SK7	SK8	SK9	SK10	SK11	SK12	SK13
SK1	1.0												
SK2	.72**	1.0											
SK3	.50**	.48**	1.0										
SK4	.28	.32	.48*	1.0									
SK5	.56**	.45	.19	.34	1.0								
SK6	-.09	.23	.23	.21	.14	1.0							
SK7	.86**	.73**	.55**	.30	.65**	.18	1.0						
SK8	.61**	.62**	.64**	.49*	.52*	.14	.73**	1.0					
SK9	.48*	.52*	.40	.08	.18	.09	.54*	.27	1.0				
SK10	.54**	.57**	.41	.41	.45*	.07	.56**	.43*	.46*	1.0			
SK11	.41	.55**	.43*	.39	.37	.30	.41	.32	.23	.58**	1.0		
SK12	.32	.39	.07	.24	.39	-.08	.37	.07	.23	.56**	.55*	1.0	
SK13	.42	.44	.66**	.39	.26	.36	.57**	.64**	.28	.34	.48*	.12	1.0

Sk1: General forming (light gage)
Sk2: Development method
Sk3: Auto body working
Sk4: Gas welding
Sk5: Arc welding
Sk6: Soldering and brazing
Sk7: Resistance welding
Sk8: Sheet-metal pressworking
Sk9: Basic bench working
Sk10: Cold metal working
Sk11: Pluming and piping
Sk12: Welding inspection
Sk13: Numerical control working

TABLE 110. Pearson correlation coefficients among skills for piping or plumbing occupation

	SK1	SK2	SK3	SK4	SK5	SK6	SK7	SK8	SK9	SK10	SK11	SK12	SK13
SK1	1.0												
SK2	.95	1.0											
SK3	.95	.81	1.0										
SK4	.99	.98	.91	1.0									
SK5	.99	.97	.92	.99	1.0								
SK6	.62	.36	.84	.54	.56	1.0							
SK7	.92	.99	.76	.96	.95	.28	1.0						
SK8	.92	.75	.99	.86	.88	.88	.69	1.0					
SK9	.98	.99	.86	.99	.99	.45	.98	.82	1.0				
SK10	.98	.99	.87	.99	.99	.45	.98	.82	1.0	1.0			
SK11	-.78	-.93	-.54	-.85	-.83	0.	-.96	-.47	-.89	-.89	1.0		
SK12	.66	.40	.87	.57	.60	.99	.32	.90	.50	.50	-.05	1.0	
SK13	.61	.82	.33	.69	.67	-.24	.86	.24	.76	.76	-.97	-.18	1.0

Sk1: General forming (light gage)
Sk2: Development method
Sk3: Auto body working
Sk4: Gas welding
Sk5: Arc welding
Sk6: Soldering and brazing
Sk7: Resistance welding
Sk8: Sheet-metal pressworking
Sk9: Basic bench working
Sk10: Cold metal working
Sk11: Pluming and piping
Sk12: Welding inspection
Sk13: Numerical control working